

REPORT OF THE

GOVERNOR'S

AQUACULTURE INDUSTRY

DEVELOPMENT

COMMITTEE



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FOREWORD

Encouraging expansion of the aquaculture industry is consistent with the State's long-term strategy for economic diversification through fostering environmentally-sound, socially-acceptable industries. A critical review of the history and current status of commercial activities gives reason to expect aquabusiness to play a major role in Hawaii's economic future.

On August 31, 1983, Governor George Ariyoshi appointed a committee of individuals from the private sector to recommend actions that would help develop aquaculture into a successful part of Island agribusiness. The Governor's Aquaculture Industry Development Committee tackled this important task with enthusiasm and proceeded in a workman-like manner to identify the relevant issues.

Aquaculture development is a complex subject which involves many environmental, social and political issues in Hawaii. Thus, this report deals with a wide variety of subjects from the availability of natural resources to the development and application of emerging technologies; from the fundamental management of a business to the timely sale of the final product. Pervasive throughout this report is the question of the role of government in the encouragement of new industries. Regrettably, time constraints permitted only a cursory discussion of some issue areas.

Many conclusions can be drawn from the report. Aquaculture does have development potential for Hawaii. It is the type of multi-faceted industry that is compatible with the local population and resources. However, the State has constraints to larger-scale commercial aquaculture which must be reduced or eliminated if the industry is to grow. Some of these are within the purview of government to remedy, while others must await evolution and the passage of time in a learning process. We are fortunate that Hawaii has talented aquaculture researchers and aggressive entrepreneurs. We must have a forum to permit public and private sector groups to actively carry the industry forward.

On behalf of the Committee, I am pleased to present this report to the Governor for his consideration and implementation. We have attempted to give cogent directions without limiting the options open to decision-makers to achieve the desired results. We leave to the State Aquaculture Development Plan update the task of expanding some of the important areas which are only touched upon in this document. Finally, the members of the Committee are grateful for the State's continuing support of the aquaculture industry and the privilege of having served Hawaii in this important mission.



William C. Rowland
Chairman
Governor's Aquaculture Industry
Development Committee

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EXECUTIVE SUMMARY

Introduction

If Hawaii wants to have a substantial aquaculture industry, it can. The potential for aquaculture in the Islands remains very strong, despite recent setbacks. Realizing this potential will require prompt action on key issues and long-term cooperative commitment by members of government, business, and labor.

Purpose and Scope of the Committee

A thirteen-member industry committee, designated the "Governor's Ad Hoc Aquaculture Industry Development Committee," was appointed by Governor George Ariyoshi to report on what needs to be done to develop aquaculture into a successful and significant sector of Hawaii's economy.

This report presents the Committee's findings and recommended actions. Background information is provided through a discussion of the history and current status of State activities in aquaculture development. Emphasis is then placed on an analysis of aquabusinesses that have recently ceased operations. The major portion of the report discusses the key issues influencing State aquaculture development, with related findings and recommended actions. Issues addressed are: 1) Management, 2) Technology and Knowledge, 3) Marketing and Economics, 4) Water and Land, and 5) Government Activities. The final section of the report addresses both the near- and long-term potential for industry expansion.

Background

The Committee reviewed the history and current status of research and commercial developments and analyzed specific aquabusiness disappointments to identify the key development issues facing the industry.

History - Commercial aquaculture in Hawaii, apart from the long-time operation of a few ancient Hawaiian fishponds, is a relatively new part of the State's economy. In 1965, investigations into techniques for farming freshwater prawns at the State's Anuenue Fisheries Research Center (AFRC) and experimentation with gray mullet at the Oceanic Institute (OI) provided important stimuli for accelerating commercial production and research, training, education and consulting activities. In the early 1970's, AFRC successfully developed a "Cooperative Agreement Program" to encourage people to try prawn farming. Hawaii's overall research efforts were further enhanced by monies from the National Sea Grant College Program, and as a result, the State became known for tropical aquaculture research. By 1976, the commercial industry consisted of 13 growers whose combined annual wholesale product value was \$200,000.

The industry continued to expand as production and research activities increased. In 1979, State funding of aquaculture research and development rose to approximately a half-a-million dollars a year to implement the recommendations of the State aquaculture development plan. By 1980, the Commercial Production sector was producing over \$1.6 million of product (wholesale) and a diverse Research, Training and Technology Transfer sector generated \$2.4 million in project value (not including State funds). The early 1980's saw several large firms either starting or contemplating multi-million dollar pilot, commercial demonstration projects.

Current Status - As can be expected of a new industry pursuing growth in a relatively-mature economy, aquaculture has experienced promising expansions, as well as disappointing setbacks. The Commercial Production sector reached \$2.6 million in wholesale product value in 1982, but fell back to \$1.6 million in 1983 with the closure of several major pilot projects. The number of firms involved in aquaculture (43), however, remained nearly the same in 1983 as in 1982 because of the entry of several small operations. The Research, Training and Technology Transfer sector valued at \$3.6 million in project value (exclusive of State funds) in 1982 rose to \$5.6 million in 1983, largely because of the increasing success of Hawaii's private consultants.

Several major development trends are apparent in today's industry.

- The combination of excellent research and effective, international consulting is gaining Hawaii a worldwide reputation for tropical aquaculture expertise.
- The State is attracting high-technology, brackish and saltwater commercial aquaculture ventures that require a sophisticated and reliable infrastructure.
- Hawaii's aquaculture industry is expanding through diversification in the species grown, the technologies utilized, and the types of commercial activities carried out.

Aquabusiness Disappointments - The Committee carefully examined local aquabusinesses which, since 1978, have ceased operations, in order to identify the reasons for these closures. Several small-scale prawn farms stopped production largely because they lacked sufficient management skills and financial resources. The large-scale aquaculture entries which ceased production were basically "probes" by large, diversified corporations. These projects were halted as a result of a combination of factors including: basic flaws in management, poor initial siting, inappropriate marketing strategy and weak financial commitment. All large-scale projects were adversely affected to some extent by biotechnical problems which contributed to uneconomical production. The Committee concluded that Hawaii's aquaculture industry today is going through a period when entrants are testing the species, technologies, and sites that can be profitably managed.

Development Issues

The number and size of successful companies will determine the contribution that aquaculture can make to Hawaii's economy. It is incumbent, therefore, that the people of Hawaii help establish conditions which will assure greater probability of success to aquaculture ventures. The Committee focused its deliberations and addressed its findings and recommendations to this end. The recommended actions to be accomplished by the cooperative efforts of Hawaii's aquaculture community are found under each priority issue.

Management - A major reason for the mediocre performance by aquabusinesses to-date, has been the farmers' lack of management skills. Three major management weaknesses have been observed: 1) poor general business management (money and personnel), 2) an inadequate biotechnical information base, and 3) ignorance or misapplication of existing information. Improvement of the level of expertise in the aquaculture industry will take time and a dedication to learning from experience.

The success of aquabusinesses in Hawaii can be increased by upgrading the management skills of individual farmers and increasing the available management information base through the following:

- Enhance existing extension capabilities.
- Offer programs in general business management for aquafarmers.
- Focus research on the development of practical farm management tools.
- Organize a statewide aquaculture association.

Technology and Knowledge - The issues of aquaculture technology and knowledge are fundamental to the development of Hawaii's commercial production and research, training, education and consulting activities. These two distinct, yet highly inter-related groups of activities, offer great opportunities for bringing revenues into the State through the sale of products and expertise.

At the present time, worldwide, a relatively small number of aquatic species and production systems have been proven to be technically and economically feasible for commercial production. This situation exists because the transfer of new technology from the laboratory to a commercial situation is a critical and difficult step.

Presently, Hawaii has a wide range of aquaculture production technologies, i.e., low, medium, and high-intensity systems. Commercial development of medium- and high-intensity systems offers the greatest economic impact to the State. Moreover, a Hawaii location offers "competitive advantages" to high-intensity aquaculture systems, because they require a reliable infrastructure.

The State has limited financial resources to apply to aquaculture technology development and expenditures should be guided by the following recommendations:

- Focus on technically-feasible species with substantial development and market potential, e.g., marine shrimp, red tilapia, and freshwater prawns.
- Determine species development priorities in close consultation with the aquaculture industry.
- Emphasize commercial-scale developments, not subsistence-level activities.
- Concentrate on medium- and high-intensity commercial developments, and selected use of Hawaiian fishponds.

Today's commercial aquaculture species and systems have a variety of immediate technological constraints which are limiting profitability. These constraints can be reduced by the following actions:

- Improve research on inventory control and harvesting technology for medium-intensity earthen-pond prawn farming.
- Conduct research to improve management techniques for Hawaiian fishponds.
- Encourage the development of new sources of stocking material from either the public or private sector.
- Assist in establishing virus-free marine shrimp broodstock for species of interest to local aquaculturists.

Hawaii has a considerable opportunity to become a major world center for aquaculture research, training, education and consulting. Food-short Third World countries wish to utilize aquaculture as one long-term option to increase their basic food supplies and to provide export income. The United States has also made a long-term commitment to increasing its aquaculture production through a variety of research and development activities. These trends are producing a strong demand for aquaculture expertise, and Hawaii's researchers and consultants are competing favorably for the increasing numbers of research, planning and development contracts; however, greater results can be achieved.

Hawaii should organize its research, training, education and consulting capabilities and develop the necessary infrastructure by performing the following:

- Hold a series of workshops for the State aquaculture community to discuss how to make Hawaii a world center for aquaculture research, training, education and consulting.

- Examine the need, potential cost and ways to attain a large-scale aquaculture research, education, training and demonstration facility.

Marketing and Economics - The crucial issues of marketing aquacultured products, and the economics of their production are considered in three parts: marketing, availability of capital, and the cost of doing business.

There is a strong feeling among aquaculture producers that the market for competitively-priced, high-quality products is vast. The local seafood market totals nearly 40 million pounds a year and is highly segmented. Per capita seafood consumption in Hawaii is more than two and one-half times the national average and this strong preference can be utilized as the base for building a substantial aquaculture industry. The primary export markets being targeted by local aquafarmers are Japan and the West Coast of the Mainland United States, both of which are important importers of seafood. The changing dietary preferences of health-conscious Americans, and the close proximity of the Japanese market bode well for future demand of Hawaii's aquacultured products. Future access to these markets, however, will require creative and timely approaches to market penetration and development.

The small size of Hawaii's aquaculture industry is limiting aggressive market expansion because of inconsistent, unpredictable production. This situation could be improved by the following actions:

- Form a professionally-managed marketing cooperative.
- Target outlets that can readily adjust to supply irregularities, and adjust the farms' operations to suit the needs of the customers.

As aquaculture production grows, orderly development of local and export markets could be fostered through the following actions:

- Concentrate on the local seafood market by focusing on import substitution.
- Develop unique market niches for local aquacultured products.
- Carry out joint State and private sector promotional campaigns for aquacultured products.

The quality assurance problems occasionally experienced by fresh-chilled and frozen freshwater prawns can be reduced by the following actions:

- Educate "middle-men" and end-consumers on the proper procedures for handling prawns.
- Improve local capabilities for conducting the necessary processing and handling research to extend the shelf-life of prawns.

A lack of investment capital for aquaculture ventures and recent exceptionally high interest rates have affected the growth of Hawaii's emerging aquaculture industry. At the present time, commercial lenders continue to view aquaculture as a highly risky business. Commercial lenders hold this opinion because most aquaculture ventures lack an adequate track record, financial data and personnel with farm management skills. Other sources of financing, e.g., venture capital or government-sponsored loan programs, are available which accept higher risks. However, investors interested in high-risk situations want projects with high potential earnings in order to justify the financial risk. Today, Hawaii aquaculture entrepreneurs must aggressively pursue high-risk capital locally and from Mainland and foreign sources. Government and the private sector should search for ways to develop greater access to sources of risk capital.

Commercial lenders and persons looking for high-risk investment opportunities need proven information in order to evaluate commercial aquaculture ventures. Assistance could be provided in the following form:

- Develop, collect, and publicize technical and financial information necessary to support and evaluate a loan request or investment prospectus.

Greater access to high-risk capital sources could be encouraged by the following:

- Publicize Hawaii's interest in attracting high-risk capital for aquaculture projects.
- Assist aquaculturists in locating and accessing high-risk capital.

The impact and effectiveness of the Department of Agriculture's Aquaculture Revolving Loan Fund (ARLF) could be improved by the following:

- Review, evaluate, and modify the ARLF so that it will be utilized more for developmental purposes and less as a "lender-of-last-resort."
- Increase the capital available through the ARLF to meet the needs of the emerging industry.
- Utilize available State aquaculture expertise in evaluating loan requests.

Aquabusiness costs fall into two general categories: start-up and operational. Significant start-up costs include acquiring land, obtaining the necessary permits, and constructing and equipping the farm. The largest operational costs are capital, labor (especially the cost of complying with the Workmen's Compensation Law), feed and energy. High start-up and operating costs act as a disincentive to aquaculture investment.

The costs associated with starting-up and operating a commercial aquaculture farm in Hawaii are generally expensive and may be reduced by taking the following actions:

- Reduce the cost burden imposed upon an aquafarmer by various government permits and regulations.
- Examine the Workmen's Compensation Program, especially the rate structure and law itself to reduce the high cost of providing benefits.
- Reduce the major operating costs of production and improve farm yields through research.

Water and Land - Hawaii's basic natural resources for aquaculture are addressed in the following sequence: fresh water, brackish water, salt water, and land.

Fresh water is available on all Islands, but there are regulatory restrictions and cost-of-development constraints associated with its use for commercial aquaculture purposes. A statewide freshwater resource management scheme is not clearly defined at this time. If freshwater aquaculture is to continue to expand, then a realistic balance between the preservation of freshwater resources for future generations and the use of fresh water for economic development must be achieved.

Presently, both State and County water resource planning and preservation policies are not adequately considering the needs of aquaculture. Development should be encouraged by carrying out the following actions:

- Accommodate non-degrading commercial uses of fresh water, such as aquaculture, in freshwater resources planning and management.
- Encourage input by aquaculturists into the development of a statewide water management scheme.
- Include aquaculture within the definition of agricultural water use for government planning and development purposes.
- Re-examine the "freshwater-use ceiling" in the Kahuku area of Oahu to increase availability.
- Emphasize recycling and multiple use of fresh water when encouraging aquaculture developments.

Hawaii has an extremely valuable aquaculture resource in the numerous volcanic and limestone aquifers from which clean, naturally-filtered brackish and salt water can be pumped. The utilization of brackish and salt water for aquaculture will make economical use of an under-utilized resource.

Use of Hawaii's brackish and salt water aquifers for land-based aquaculture, without threatening freshwater supplies and soil productivity, can be encouraged by the following:

- Establish a policy position that land-based brackish and saltwater aquaculture is acceptable in Hawaii, unless potential degradation of drinking water is demonstrated.
- Encourage direct brackish and salt water discharges from coastal aquaculture facilities, when nearshore uses and environments are compatible with the activity.

Hawaii has large amounts of land suitable for commercial aquaculture, though specific sites are not well-defined. Presently, prospective aquaculturists are having great difficulty in finding sites because land is expensive to buy or lease, and water may not be readily available. Finding a good site is also difficult because land in Hawaii is controlled by a few groups, and these entities are not well-informed about commercial aquaculture opportunities. If aquaculture is going to expand in Hawaii, then sites must be better-defined and made more accessible to aquaculturists.

Aquaculturists could be greatly assisted in finding and securing appropriate, reasonably priced sites if the State and private landholders cooperatively undertake the following recommendations:

- Identify land suitable for commercial aquaculture.
- Make State lands available for aquaculture at reasonable lease rates.
- Consider a statewide aquaculture park program.

Government Activities - State and County governments have major roles to play in the encouragement of aquaculture development in Hawaii. Government activities are considered in three areas: development, research and extension, and regulation.

The public sector has been very supportive of aquaculture development. The formulation of a State aquaculture plan to focus private and public sector efforts was a major step. The Department of Land and Natural Resources (DLNR) is the lead agency for statewide aquaculture development and is responsible for the implementation of the Aquaculture Plan. The Departments of Agriculture and Planning and Economic Development also assist in State development efforts by providing financial assistance and research support, respectively. The University of Hawaii system provides a nucleus of personnel and facilities to conduct aquaculture research, training and education activities. The County governments of Kauai and Maui are in the process of preparing County aquaculture development plans to guide their efforts.

Communication and coordination among governmental agencies and between the government and the private sector are areas that need constant attention. Steps should be taken to improve the communication of industry priorities to government decision-makers. The private sector believes government should concentrate its efforts on research and development activities which reduce aquabusiness start-up and operating costs, and most importantly, investment risks.

Hawaii's aquaculture industry should not be built on long-term subsidies; however, short-term government assistance is essential to successful expansion. The most economical way the State can increase its assistance efforts is to improve the effectiveness of the programs and facilities already in place and add appropriate new ones.

Communication and coordination between the public and private sectors could be improved by undertaking the following:

- Communicate the State's aquaculture development policy to all levels of government.
- Form an Aquaculture Development Coordination Council to provide a forum for public and private sector groups to discuss development issues.

The aquabusiness development climate in Hawaii could be further enhanced by taking action on the following:

- Update the State Aquaculture Development Plan to formulate new guidelines for development which reflect the aquaculture industry's current development pattern, stage of maturity and need for assistance.
- Focus government assistance programs on reducing industry's start-up and operating costs and lowering the risk of investment.
- Identify and evaluate various aquabusiness investment incentives, e.g., tax incentives to attract new businesses and encourage existing firms to expand.

The State of Hawaii is providing research and development support to encourage the expansion of aquaculture. Since 1975, approximately \$5 million of State funds have been spent on research projects, and in the same period, an estimated \$7 million of Federal monies have come into the State. The State is currently providing approximately one million dollars a year in staff and research project support towards aquaculture development.

More effective utilization of existing research budgets can be achieved through closer communication with the industry and joint determination of research priorities. State support of basic and applied research has clearly been an important incentive to encourage private investment. State-sponsored

extension efforts, particularly those of the Anuenue Fisheries Research Center, have played a major role in development. However, extension services and other research support must be periodically evaluated, re-programmed and enhanced to keep pace with industry development trends.

The current State-sponsored aquaculture research and extension program could be improved by striving to define project objectives which better reflect the industry's production and marketing problems. Initiatives should follow these recommendations:

- Develop a formal mechanism for the aquaculture industry to provide input into State funding decisions.
- Direct the bulk of State support to the encouragement of medium- and high-intensity commercial aquaculture operations.
- Enhance existing extension capabilities to accommodate the current and projected mix of commercial species and technologies, e.g., re-program Anuenue Fisheries Research Center activities.

Federal, State and County permits and regulations have a significant impact on commercial aquaculture development in Hawaii because of the time and cost required for permit compliance. Although some streamlining of the permit process has occurred, aquaculture is little understood by the existing regulatory regime. Regulations can be grouped into two broad categories: those that impact on the start-up of aquabusinesses, and those that impact on general operations. Proper planning and siting of aquaculture facilities, and the involvement of regulatory personnel early in the planning process can greatly reduce regulatory problems. From a policy perspective, government regulations should promote, not obstruct, aquabusiness development.

Generally speaking, the regulatory regime in Hawaii governing aquabusinesses was established without adequate consideration of the State's unique environment and aquaculture's low pollution potential. Improvements in the current situation could take the following form:

- Survey members of the industry to determine which laws, regulations or codes are being misapplied.
- Consider reducing the time and cost of preparing Environmental Impact Assessments or Statements by having certain aquaculture activities defined as an exempt class of action and/or by carrying out "Master" EIA's or EIS's for certain areas of the State.
- Regulate direct aquaculture effluent discharges by granting "zone-of-mixing" variances.

- Recommend to the Environmental Protection Agency that the criteria for the Federal National Pollutant Discharge Elimination System permit exemption for aquaculture be raised to 500,000 pounds of production a year.
- Recommend to the U.S. Army Corps of Engineers the issuance of general or regional permits for aquaculture activities.
- Examine Historic Site Preservation laws and regulations to determine if ancient Hawaiian fishponds can be exempted to allow productive use.
- Resolve the jurisdictional and policy conflicts between the State and the County over fresh water, e.g., aquaculture use of the subsurface outflow of fresh water along the coast.
- Clearly define the statutory and policy guidelines which govern the use of animal manures in aquaculture systems.
- Review current aquatic species importation regulations and procedures to streamline, but not weaken, the existing system.

Future of the Industry

Aquaculture development fits into the State's overall strategy for economic development and diversification. It is a flexible, multi-purpose industry that can be economically viable at a wide range of scales, and produces a variety of products and services. Moreover, commercial aquaculture has the potential to take advantage of under-utilized resources, e.g., brackish and salt water, agricultural wastes, and lava lands. This flexibility will ultimately help aquaculture enterprises mitigate the aggregate disadvantages of a Hawaii location (e.g., isolation from major markets, limited sources of high risk capital, and higher costs of doing business), while benefiting from the collective advantages (e.g., a year-round, warm climate, abundant water supplies, sophisticated infrastructure, large local market, and political stability under the U.S. flag).

Aquaculture has a potentially bright future in Hawaii if existing constraints are reduced or eliminated and if lenders and investors begin to confidently back aquabusiness development. By 1990, both commercial production and research, training, education and consulting activities are expected to increase significantly. Moreover, by the year 2000, substantial revenues could be generated from production and service activities.

The worldwide focus on increasing food supplies and encouraging economic development in Lesser-Developed Countries is expected to continue into the next decade. This pronounced trend could allow Hawaii's Research, Training and Technology Transfer sector to generate over \$10 million in annual project value by 1990. However, to take advantage of these opportunities, the State must, in the long-term, consider the following:

- Networking of existing resources and facilities, and constructing a large-scale research, training and demonstration facility would improve Hawaii's competitive position.
- Developing a wide variety of aquaculture training and education curricula would broaden the State's saleable skills.
- Marketing of Hawaii as a site for aquaculture research, training, education and consulting activities would place the State in the forefront of the expanding world aquaculture field.

Near-term growth for the Commercial Production sector appears more promising, despite the poor showing in 1983. Based on the estimates of those companies with announced plans, this sector could reach \$20 million in wholesale product value by 1987. State officials strongly suggest that the Commercial Production sector could reach over \$50 million in wholesale product value by 1990. While this is a bold projection, it is based on the State's ability to successfully attract some of the 15 large-scale projects which are currently evaluating Hawaii as a site for their investment. Moreover, if these projects are successful, other new investments will follow. These 1987 and 1990 projected values for the aquaculture industry compare favorably with the leading diversified agriculture crops in the Islands.

Year 2000 projections for the growth of both the Research, Training and Technology Transfer sector and the Commercial Production sector are more speculative. The State Aquaculture Plan's projection of a \$334 million Commercial Production sector by 2000 should be re-evaluated in light of changing technologies and markets, and potentially-available resources, e.g., water and land.

Clearly, aquaculture development fits well into the State's strategy for long-term, environmentally-sound economic development. It is capable of filling a multitude of market niches in production and technology sales. Greater success will depend, in the near-term, on improving the industry's level of management skills, increasing profitability, and making the State a more attractive place in which to invest. Long-term development will require a better infrastructure and a more timely development of export markets. The Committee concludes that the aquaculture industry should adopt the following goals:

Near-term - Strive by 1990 to make commercial aquaculture production the State's largest single diversified agriculture activity, and develop a sustained source of revenue from national and international research, training, education and consulting.

Long-term - Strive by the year 2000 to make Hawaii an important tropical seafood production site, and a center of excellence for aquaculture research, training, education and consulting.

If decisive action is taken now to address current problems and reduce constraints, aquaculture can, in time, grow to become a highly significant part of Hawaii's economy.

I. INTRODUCTION

Is aquaculture destined to become a significant part of Hawaii's economic future, or will it remain a minor contributor to diversified agriculture? After a very encouraging beginning, questions have arisen regarding the industry's potential to generate substantial revenues. Skeptics say that aquafarms cannot achieve profitability and, therefore, will not be able to attract the private investment needed to create a major industry.

Importantly, it is not so much a question of whether or not Hawaii will have an aquaculture industry, but rather, how large that industry will ultimately be. If Hawaii wants to have a major aquaculture industry, it can. But as in any new field, where laboratory research must be expanded to commercial-scale development, and where old ways of thinking must accommodate a new technology, major constraints exist and must be overcome. Identifying and ultimately finding solutions to these constraints will require prompt action on key issues and long-term cooperative commitment by members of government, business and labor.

II. PURPOSE AND SCOPE OF THE COMMITTEE

Governor Ariyoshi, in his 1983 State-of-the-State Address, announced that an ad hoc committee of industry representatives would be appointed to study the problems that are presently constraining aquaculture development in Hawaii (Appendix A). The Governor's Ad Hoc Aquaculture Industry Development Committee (GAIDC) was formed and given a mission to:

"Submit a report to the Governor on what needs to be done to develop Hawaii's commercial aquaculture industry into a successful and significant sector of Hawaii's economy."

Specifically, the thirteen-member committee was asked to: 1) study the problems currently affecting the industry and those that lie ahead, 2) identify Hawaii's major advantages and disadvantages for aquaculture development, 3) identify the Islands' significant resources, and 4) make recommendations on how and where to focus State efforts to make future aquaculture expansion a reality.

Report of the Governor's Ad Hoc Aquaculture Industry Development Committee presents the Committee's findings and recommended actions. The history and current status of State activities in aquaculture development are considered first. Emphasis is then placed on an analysis of aquabusinesses that have recently ceased operations in order to understand why they went out-of-business. The major portion of the report discusses the key issues influencing State aquaculture development, and related findings and recommended actions. Issues addressed are: 1) Management, 2) Technology and Knowledge, 3) Marketing and Economics, 4) Water and Land, and 5) Government Activities. Knowledgeable individuals from the public and private sectors were asked to speak on these issues to supplement the members' expertise (Appendix B). The final section of the report addresses both the near-term and long-term potential for industry expansion.

III. BACKGROUND

This section highlights the history and current status of Hawaii's aquaculture industry with special emphasis on recent aquabusiness disappointments. This information provided a basis for the Committee to identify the key issues affecting aquaculture development in Hawaii.

A. History of the Industry

The practice of aquaculture in the Islands dates back more than 600 years. At one time, there were more than 300 man-made coastal fishponds, totaling in excess of 6,000 acres. Most of these ancient food production systems have deteriorated beyond use, but remnants remain on nearly every island. Moreover, at least five ponds are in active production today.

The modern aquaculture era began in 1965 when the Department of Land and Natural Resources' Anuenue Fisheries Research Center (AFRC) began the research and development of practical, mass-culture techniques for larval and juvenile prawns. Also, in the early sixties, the Oceanic Institute (OI) began a research program on the culture of gray mullet. Research there focused on developing techniques for the artificial spawning and hatchery production of mullet in order to supply stocking material to farmers in Hawaii and in the food-short Lesser-Developed Countries. These two activities provided the stimulus for the eventual development of commercial aquafarms and the proliferation of research, training, education and consulting activities in Hawaii.

Further research of prawn farming techniques continued in the early 1970's at AFRC and at commercial-scale demonstration ponds on a privately-owned farm in Punaluu. In 1974, AFRC accelerated its Cooperative Agreement Program. Participating private prawn farmers were provided with free stocking material and management advice for a given period of time in exchange for production and water quality information. The program generated a great deal of interest, and gradually more people entered into commercial prawn farming, usually on a small-scale.

Concurrently, the State's aquaculture research activities began to expand into other areas. In 1968, the University of Hawaii (UH) was designated a National Sea Grant College by the United States Department of Commerce, and the UH Sea Grant College Program made a significant commitment to aquaculture research. Under the auspices of this program, many other species (besides freshwater prawns) were investigated for their aquaculture potential. It was largely due to the efforts of AFRC, the UH Sea Grant College Program and OI that Hawaii became well-known for its expertise in tropical aquaculture research.

By 1976, Hawaii had thirteen commercial aquafarms and the beginnings of an aquaculture industry. The wholesale product value for that year was a little over \$200,000 (Table 1). These operations (which included six prawn farms) were mostly small-scale, self-financed farms run by families. Several commercial operations utilized ancient Hawaiian fishponds and obtained their stocking material from the surrounding ocean.

It is important to note that two potentially large operations (Fishfarms Hawaii, which is still in business today, and Oahu Oyster Farm, Inc., which later became the Kahuku Seafood Plantation) existed in 1976. One operation utilized earthen ponds to grow prawns and channel catfish, while the other developed a high-intensity, raceway system to cultivate oysters. Several sources of capital, including the State Department of Agriculture's Aquaculture Revolving Loan Fund, were utilized to finance these endeavors.

The industry continued to gradually expand with more new prawn farms started through the Cooperative Agreement Program in the late 1970's. In 1977, Kilauea Agronomics, a C. Brewer Company, established a large-scale prawn farm on Kauai. One hundred acres of ponds were developed in the first phase of the farm's construction. This commitment by a major Hawaii corporation was widely hailed as a sign that prawn aquaculture had become an attractive investment.

The publication of an aquaculture development plan in 1979 signaled the beginning of a period of new, increasingly enthusiastic state efforts to promote aquaculture. Research and development funding was increased to approximately half-a-million dollars a year, in order to begin implementation of the Plan's recommendations. The State funds acted as seed monies and matched greater amounts of Federal aquaculture research funds (mostly from the National Sea Grant Program). Most research, training, and educational activities were carried out at UH, AFRC, and OI.

By 1980, the service-oriented Research, Training and Technology Transfer (RT & TT) sector of the industry, as it is called in the State Aquaculture Plan, had generated \$2.4 million in annual project revenues, not including State funds (Table 2). Importantly, a few Hawaii-based aquaculture consultants were beginning to bid aggressively on an increasing number of overseas aquaculture planning and development projects. These activities began to pay off, as 1981 RT & TT project revenues of nearly \$4 million far exceeded the \$1.6 million wholesale value of commercial production (Table 1).

The beginning of the 1980's saw further increases in local commercial production activities. Most new farms continued to be small-scale operations with only a few employees. Local aquaculturists also began to grow a wider variety of species. Several multi-million dollar pilot demonstration projects (i.e., Amfac Aquatech, IKKO Hawaii Aqua Culture, Ltd., Marine Culture Enterprises, and Kahuku Seafood Plantation began testing the technical and economic

Table 1 Growth of the Commercial Production Sector of the
Aquaculture Industry in Hawaii 1976-1982^a

	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>
Total Acreage	235	246	320	493	575	547	643	508
Prawns	26	33	107	275	310	260	306	254
Other ^b	209	213	213	218	265	287	337	254
Total Production (1,000 lbs) ^c	94	123	179	246	320	339	551	423
Prawns	43	55	110	205	300	240	317	269
Other ^b	51	68	69	41	20	99	234	154
\$ Total Value (\$1,000) ^e	210	281	525	1,531	1,655	1,868	2,625	1,614
Prawns	152	206	420	787	1,125	1,031	1,553	1,390
Other ^b	58	75	105	744 ^d	530	837	1,072	224 ^d

^a Information summarized from an industry survey.

^b Includes a mixture of shrimp and post-larval prawns, oysters, brine shrimp, carp, catfish, koi, tropical fish, trout, mullet, tilapia, marine shrimp and American lobster, depending on the year.

^c Excludes items not sold by weight.

^d Value of post-larvae estimated.

^e Wholesale product value.

Table 2 Growth of the Research, Training and Technology
Transfer Sector of the Aquaculture Industry in
Hawaii 1980-1983^{ab}

<u>Year</u>	<u>Project Value (millions \$)^c</u>
1980	\$2.4
1981	\$3.8
1982	\$3.6
1983	\$5.6

^a Information summarized from a survey of State research, training, education and consulting activities.

^b Measured as gross project value, pro-rated over the year, for research, training, education and consulting services supplied by the public and private sectors. For example, if a consultant or a university researcher received a \$300,000 Federal contract for three years, then \$100,000 of project value was counted each year.

^c Value does not include State matching and seed monies.

feasibility of their projects at commercial-scale. The assumption was that if the risk and return on investment proved acceptable, then millions of additional dollars would be spent on the construction of large-scale facilities.

B. Current Status

As can be expected of a new industry pursuing growth in a relatively-mature economy, aquaculture has experienced promising expansion, as well as disappointing setbacks.

By the end of 1982, the Commercial Production (CP) Sector of the industry was valued at \$2.6 million in wholesale product value (Table 1). This sector consisted of 44 operations, 21 of which were prawn farms. The remaining farms grew a wide variety of fresh, brackish and saltwater species. The majority of farms were small to medium-sized operations and family businesses (under 30 acres). Several potentially major companies continued their commercial feasibility tests in 1982, e.g., ORCA Sea Farms and Marine Culture Enterprises. Several other large companies ceased operations.

The 1983 State industry survey revealed a major drop in the value of the commercial production. A wholesale product value of \$1.6 million, from 43 operations, was a result of a number of factors including loss of production from the several failed pilot-demonstration operations the previous year, i.e., IKKO Hawaii Aqua Culture, Ltd. and Amfac Aquatech, as well as the bankruptcy of the Kahuku Seafood Plantation. The value of freshwater prawn production, despite the closure of the Amfac operation, remained relatively stable due to increases in farm production and wholesale price, and expansion by several farms. When asked in the 1983 industry survey whether or not they made money in 1983, 51% of the farmers said "yes", 39% said "no" and 10% said they "broke even" or "did not know."

The Research, Training and Technology Transfer (RT & TT) sector reached a project value of \$3.6 million in 1982. In the private sector, at least ten consultants were actively bidding on local and international aquaculture planning and development jobs, and feasibility studies. Scientists from UH and OI also continued to attract research funds from a variety of public and private sources.

Internationally, in 1983 various Asian-Pacific countries, international assistance agencies and regional development banks continued to emphasize aquaculture as an economic development strategy to increase basic food production. Hawaii's research, training, education, and consulting activities benefited significantly, indicated by the \$5.6 million of project value generated by this sector during the year. A large portion of this value came from several private sector consultants who were successful in landing major development projects in Asia.

Review of the current situation indicates that both the RT & TT sector and the CP sector are generating substantial revenues, with potential for future expansion. The combination of excellent research and effective international consulting services are establishing Hawaii as a center of tropical aquaculture expertise. The State continues to be known as a world-leader in freshwater prawn research and is also becoming well-known for its work with other tropical marine species (e.g., marine shrimp and mahimahi). Technical improvements to local aquaculture activities, and employment of skilled local people are direct benefits of Hawaii's increasing world role.

In the commercial production area, a wide diversity of species, scales of production and technologies are developing in the State. Notably, Hawaii is attracting high-technology brackish and saltwater aquaculture ventures which proceed through a "proof of concept" stage before expanding to commercial scale. These energy-intensive and capital-intensive systems do not locate in Lesser-Developed Countries because they need sophisticated, reliable infrastructure, skilled labor, and politically-stable governments to secure their investments. This interest from "leading edge," high technology projects, in combination with the increasing numbers of small- and medium-sized farms, form the foundation for a Hawaii seafood production industry to service both local and export markets.

C. Analysis of Recent Disappointments

Expansion of Hawaii's commercial aquaculture industry has occurred, but progress has not been made without disappointments and well-publicized failures. Nationally, two-thirds of all small businesses fail within their first five years. Since 1978, approximately six small and four large, local aquabusinesses have ceased operations (Table 3). This loss rate, when compared with the forty-three commercial operations which exist today, seems much better than the average. However, though no exact figures are available, the investment by the four large firms previously mentioned appears to represent nearly two-thirds of the estimated \$20 million to \$30 million invested in commercial aquaculture in the past five years. An analysis of these disappointments was carried out to determine if common problems could be identified.

The six small aquabusinesses which withdrew from the industry all grew freshwater prawns. These farms, which participated in the State's Cooperative Agreement Program, averaged between one-quarter acre and two acres in size. In many cases, prawn production was supplemented by, or integrated into, agricultural activities. These small farms had very little impact on the overall prawn supply.

There were a variety of reasons for the termination of the small freshwater prawn operations. Low yields and high production costs occurred due to poor farm management. Other reasons given by the farmers included: 1) loss of interest, 2) more time needed to be devoted to agricultural crops, 3) poor

Table 3 Brief Descriptions of Commercial Aquaculture Projects Which Have Recently Ceased Operation

<u>Firm</u>	<u>Size</u>	<u>Scale</u>	<u>Species</u>	<u>Operation Begun</u>	<u>Operation Ceased</u>	<u>Reasons Given By Companies</u>
A. Small farms (6)	less than 2 acres each	Small Commercial	Prawns	1977 to 1979	1980 and 1981	Lost interest; unavailability of post-larvae; poor site; could not negotiate long-term lease.
B. C. Brewer and Company (Kilauea Agronomics) Kilauea, Kauai	100 acres of ponds, (planned for 300 acres)	Large Commercial, with hatchery and processing plant.	Prawns	1978	Dec., 1981	Site was too cold; uneconomical production.
C. Amfac (Amfac Aquatech) Kekaha, Kauai	35 acres of ponds, (planned for 350 acres)	Pilot Demonstration, with hatchery and processing	Prawns	1980	Sept., 1982	Mainland United States market was thought to be insufficient to justify major corporate investment; questionable product acceptance.
D. IKKO Hawaii Aqua Culture Company, Ltd. Kahuku, Hawaii	13 acres of ponds, (planned for 50 acres)	Pilot Demonstration, with hatchery.	Japanese Tiger Shrimp	1979	Dec., 1982	Inability of the technical support group to deliver results; harassment by regulatory agencies.
E. Kahuku Seafood Plantation Kahuku, Hawaii	4-acre site, raceways and ponds.	Pilot Demonstration	Oysters	1975	Jan., 1983	Unavailability of seed oysters from the Mainland; poor production due to technical problems; damage from Hurricane Iwa; poor personnel management.
	45-acre site, raceways and ponds.	Commercial Scale	Oysters	Nov., 1981	Jan., 1983	

siting of ponds (e.g., excessive water leakage), and 4) problems in lease negotiations. In addition, several farmers stopped production during 1981 and 1982 because the State hatchery was having critical production problems and could not supply stocking materials on a consistent basis.

The multi-million dollar, large-scale aquaculture ventures which failed also had a number of characteristics in common. Most were "probes" by large diversified corporations to determine if aquaculture could be a profitable part of their business. Though the species differed, i.e., prawns, shrimp and oysters, most ventures began as pilot-demonstration projects to determine the basic technical and economic feasibility of a production system at a particular site. The C. Brewer operation was an exception, as they moved directly into the construction and operation of a 100-acre freshwater prawn farm. This farm was, at the time, the largest prawn farming operation ever attempted. The withdrawal of these large-scale ventures from aquaculture caused major impacts on the credibility of the industry.

The four ventures publicly cited a variety of reasons for ceasing operations (Table 3). Unmanageable siting difficulties were emphasized by C. Brewer and IKKO. Persistent technical problems which contributed to uneconomical production were cited by C. Brewer, IKKO and the Kahuku Seafood Plantation. Amfac pointed to a questionable U.S. market for frozen freshwater prawns as being of crucial importance in the decision not to invest additional millions in full-scale corporate expansion. IKKO, a Japanese company, experienced continual disputes with the U.S. Fish and Wildlife Service and the City and County of Honolulu Board of Water Supply which, they claimed, caused large cost overruns and left them with a very negative impression of Hawaii's aquabusiness climate.

In addition to the well-publicized reasons given by the four companies for discontinuing these large-scale projects, other factors clearly affected their decisions. Broad corporate objectives may have changed during the pilot project, either from personnel changes in top-level management or from poor performance in other areas of the company's business. Diversification into aquaculture may not have fit into the company's new objectives. Moreover, corporate managers must have a constant profit picture, and internal politics tend to pressure management decisions to favor traditional, proven crops. It is also apparent that the patience necessary to help a new technology through the initial "start-up" and market development stages was not present in these companies.

Significantly, three of the large-scale aquabusiness ventures which probed into the technical and economic feasibility of aquaculture, were backed by varying degrees of corporate commitment. Reportedly, technical advice, when needed, was not sought or, when it was obtained, was not applied. A breakdown in communication between parent company officials and the production unit staff was apparent in some instances. Poor management and resource allocation deci-

sions resulted, and project feasibility and profit projections suffered. In the final analysis, senior management did not have confidence in the project's profitability and made a management decision to discontinue the operation.

All of the failed ventures had certain problems in common. Small-scale farmers generally appeared to lack sufficient management skills and financial resources. The large-scale aquaculture attempts had problems in basic management, poor initial siting, inappropriate marketing strategy, and weak financial commitment. All large-scale projects were adversely affected to some extent by biotechnical problems, which contributed to uneconomical production. In some respects, the lack of success was, in large part, the project's own fault.

Aquaculture in Hawaii is going through an initial "shake-out" period. The industry is still searching for the species and technologies that will work consistently and profitably. Moreover, every venture is somewhat unique since every production system and every site is different. Each company is organized differently according to its technical resource base, management style, capital and overhead structure and marketing strategy. Most importantly, each will execute its business plan with varying degrees of effectiveness.

IV. ANALYSIS OF DEVELOPMENT ISSUES

The contribution that aquaculture can make to the Hawaiian economy will be determined by the number and size of successful companies. It is incumbent, therefore, that the people of Hawaii help establish conditions which will assure greater probability of success to aquaculture ventures. The Governor's Committee focused its deliberations and addressed its report to this end.

The key development issues identified by the Committee are: 1) Management, 2) Technology and Knowledge, 3) Marketing and Economics, 4) Water and Land, and 5) Government Activities. Major findings are highlighted in the following sections, and provide the basis for the problems and recommended actions discussed below.

A. Management

Most problems in commercial aquaculture in Hawaii today are due to poor management. In general, aquabusinesses have exhibited three major management weaknesses: 1) poor general business management, 2) inadequate biotechnical information base, and 3) ignorance or misapplication of existing information.

Poor general business management is more prevalent in commercial aquaculture than it is in most other business endeavors. A critical examination of aquabusinesses suggests that aquaculturists are often lacking in basic business skills, such as task management, money management, and marketing. Aquabusinesses, particularly small-scale operations, tend to rely on very informal and unplanned management rather than well thought-out programs.

The basic biotechnical information available for managing an aquaculture farm is also inadequate in some instances, and tends to magnify the adverse effects of poor general business management. Commercial aquaculture relies a great deal on the farmer's practical or "green thumb" experience. Detailed scientific understanding of the biology and chemistry of many production systems has not been fully developed and further study in this area is necessary. Moreover, aquaculture is lacking in farmer-usable management tools, technologies and techniques. The beginnings of improvement in this area lie in research and extension.

Farm management and skillful application of available "know-how" have figured greatly in the measure of success and failure in Hawaii's aquaculture industry, particularly in the case of freshwater prawns. Production inconsistencies can be attributed in many instances to the lack of application or poor application of well-known, state-of-the-art information, rather than unknown factors related to a species or production system. Human error and human ignorance are major contributors to an aquafarm's failure to meet production goals. These are basically problems in farm operations, personnel management, and extension education of the farm operators.

In conclusion, a major reason for mediocre performance in aquabusinesses has been the poor management skills of farmers. Good management is utilizing accurate information at the right time and learning from experience the proper techniques necessary to increase production. It should be emphasized that improvement in the overall expertise of the aquaculture industry will take time and a dedication to learning from past mistakes.

Aquafarmers will profit a great deal from mastering farm operation and general business management skills. Hawaii, in general, must improve the quality of its attempts at aquabusiness by developing pools of experienced personnel, conducting research to supplement the existing data base and providing adequate extension education opportunities. General aquabusiness performance can be improved through the following actions:

- Existing aquaculture extension assistance provided through the State of Hawaii and joint Federal/State programs should be given the resources (manpower and funds) to carry out projects and programs to increase the farm management skills of commercial aquaculturists.
- Special programs and practical training in general business management, as applied to aquafarming, should be offered by the University of Hawaii and the Community College System.
- State research efforts should be balanced between development of practical farm management tools and techniques, and fundamental scientific understanding of the production system.
- Commercial aquaculturists should consider organizing into a statewide association which could provide an industry focus, as well as a forum for the exchange of ideas and information. This association could also serve as a collective voice to present the industry's concerns to the Administration and the Legislature and input these concerns into government decisions.

B. Technology and Knowledge

The issues of aquaculture technology and knowledge are fundamental to the development of the industry's commercial production and research, training, education and consulting activities. Technology is considered, for the purposes of this report, to encompass those species and systems which are being commercially developed in Hawaii, while knowledge refers in broad terms to the diverse activities of research, training and technology transfer. These two distinct, yet highly inter-related groups of activities, offer great opportunities for bringing revenues into the State through the sale of products and expertise.

1. Technology

Around the world, a relatively small number of aquatic species have been shown to be technically and economically feasible for commercial aquaculture (Table 4). Many other economically important species are about to begin commercial demonstration or are being extensively researched in numerous laboratories. Finfish constitute most of the world's commercial aquaculture production, while relatively little is derived from crustacea (e.g., shrimps, prawns and crabs), despite the very large world market for these species. Most Hawaii firms have targeted prawns and shrimps for commercial development.

Aquaculture as it is practiced around the world is a diverse, multi-purpose activity which can take a variety of physical forms, depending on the species and production system used. Most aquaculture is associated with the production of food for direct human consumption; however, aquaculture can also be utilized to replenish commercial and recreational fisheries, treat wastes, and produce industrial chemicals, ornamental fish and baitfish.

Technical information is extensive for a few species (e.g., trout, catfish and oysters) though there are no comprehensive "how-to" manuals as yet. For such other species as Hawaiian prawns and marine shrimp, the technical information base is sufficient to attempt commercial-scale development, but the risk of failure is much greater. For those species which have been successfully cultured in the laboratory, but not yet at commercial-scale (e.g., mahimahi and opihi), the biotechnical information available is limited and the degree of risk in achieving a profitable commercial venture is very high. This situation exists because the translation of a technology from the laboratory to a commercial situation is a critical and often difficult step.

While it is difficult to characterize every possible aquaculture system into a precise category, in general, systems can be classified as being of low, medium or high-intensity (Table 5). Each system has its own peculiar development problems. Hawaii has opportunities for commercial operations in all forms, though the greatest economic impact will be from medium and high-intensity systems.

Table 4 Significant Commercially Aquacultured Species and Species Groups From Several Countries

<u>Japan</u>	<u>Taiwan</u>	<u>Israel</u>	<u>USA</u>
Mullet	Freshwater Prawn	Freshwater Prawn	Freshwater Prawn
Oysters	Tilapia	Tilapia	Tilapia
Clams	Mullet	Mullet	Oysters
Common Carp	Oysters	Common Carp	Clams
Koi Carp	Clams	Silver Carp	Trout
Trout	Carp	Grass Carp	Catfish
Sweet Fish	Milkfish		Crayfish
Salmon	Japanese Eel		Salmon
Japanese Eel	Marine Shrimp		Freshwater Game Fish
Yellow Tail	Lobster		Freshwater Aquarium Fish
Sea Bream	Seaweed		Mussels
Horse Mackerel			
Puffer			
Filefish			
Marine Shrimp			
Abalone			
Seaweed			
Crabs			

Table 5 Generalized Characteristics of Low, Medium and High-Intensity Aquaculture as Practiced in Hawaii

<u>Characteristic</u>	<u>Intensity</u>		
	<u>Low</u>	<u>Medium</u>	<u>High</u>
Yield/Acre (lbs/acre)	low (100's lbs)	medium (1,000's lbs)	high (10,000's lbs)
Land Used	large	in between	small
Direct Employment	small	in between	large
Employment/Acre (jobs/acres)	small (1 job/50 acres)	in between (1 job/10 acres)	large (1 job/acre)
Initial Capital Investment (dollars/acre)	small (\$100's acre)	in between (\$1,000's/acre)	large (\$10,000's/acre)
Water Use (gallons/day)	low (0 to 1,000's GD)	medium (20,000-50,000 GD)	high (1 M - 20 M GD)
Water Use	salt	salt, brackish and fresh	salt and brackish
Manageability	easy	difficult	very difficult
Hawaii's Competitive Edge	none	small	substantial

Ancient Hawaiian fishponds, managed by traditional methods, are examples of low-intensity aquaculture. They do, however, offer limited management options because of their size and construction.

Medium-intensity aquaculture is represented by the earthen pond culture of Hawaiian prawns. Ponds, usually one acre in size, are often constructed on primary agricultural land. Earthen ponds offer greater control of the growing environment.

High-intensity systems are typified by concrete and wooden raceway systems which reportedly can produce hundreds of thousands of pounds of animals per acre of water per year. High-intensity systems are capital- and labor-intensive on a per-acre basis. Since total control of the system is possible, management options are numerous, but these are generally considered difficult and expensive to implement. Moreover, the operational costs (e.g., for pumping water, feed and labor), are large in comparison to the other systems, but the total profit potential is greater.

Species selection is a crucial question for Hawaii's aquaculturists. There is a limited number of economically-important indigenous and native species suitable for major-scale commercial development (e.g., opihi, mahi-mahi, ogo, and mullet), therefore, diversification and expansion of the industry will rely on selected importation. Importation of exotic species carries with it the risk of introduction of aquatic diseases, as well as the possible ecological consequences of escape. Another species selection factor is the Island's subtropical climate which provides a cooler temperature regime than may be desirable for the optimal culture of certain tropical warmwater species. Mild seasonality (winter/summer temperature fluctuations) can cause variable growth rates in pond production systems. It should be noted that controlled environment, highly intensive culture systems are not affected by ambient temperature fluctuations.

Hawaii has a variety of aquaculture development opportunities for a wide range of species and technologies. Limited availability of State funds necessitates prioritization of aquaculture development initiatives. Prioritization should be guided by the following considerations:

- The State should concentrate its development efforts on technically-feasible species with substantial development and market potential, e.g., marine shrimp, red tilapia and freshwater prawns. Other candidate species, such as trout, channel catfish, Chinese catfish, Chinese carp and mullet, are suitable for small, family-run operations that would service the local market.
- The State should develop its species development and funding priorities in close consultation with the aquaculture industry.

- The State, should emphasize the development of commercial-scale aquaculture over subsistence or backyard aquaculture, since commercial-scale aquaculture has a far greater economic impact.
- The State and the private sector should concentrate on medium and high-intensity commercial aquaculture systems with the exception of the restoration of appropriate ancient Hawaiian fishponds.

Commercial aquaculture species and systems presently utilized in Hawaii have a variety of biotechnical constraints limiting profitability. These constraints can be reduced by the following actions:

- The State should improve current research efforts aimed at developing cost-effective inventory control methods and improving harvesting efficiency for medium-intensity earthen-pond prawn farming. More imaginative approaches to solving problems and intensification of selected efforts could more effectively utilize limited funding.
- The State should conduct research to improve management techniques for Hawaiian fishponds. These fishponds are an under-utilized resource which could be brought into productive and profitable use.
- The State should encourage the development of new sources of stocking material in the public and private sector. State facilities, such as the Anuenue Fisheries Research Center, should be primarily utilized to carry out research on hatchery technology for existing and new commercial species.
- The State should assist in establishing virus-free marine shrimp broodstock for species of commercial interest to local aquaculturists. Virus-free stocks are needed by both researchers and commercial aquaculturists to further expand marine shrimp farming in the Islands.

2. Knowledge

Aquaculture has been identified as one long-term means of improving the protein supply in food-short Third World countries. There are numerous job opportunities for qualified aquaculture consultants today, as organizations such as the Asian Development Bank and the World Bank have devoted large sums to aquaculture planning and development around the world. Often these large country-wide development programs have large training and education components.

Hawaii's Research, Training and Technology Transfer sector, particularly the private consultant segment, is very active in competing for international planning and development jobs. In addition, the United States has also made a long-term commitment to increasing its aquacultured seafood production through a variety of research and development activities. Though competition

is keen, Hawaii has a great opportunity to establish itself as a major international center for aquaculture research, training, education and consulting. The components of such a major center are largely present (with some key exceptions), but they are currently not well-organized.

There is general concern that exporting Hawaii's aquaculture knowledge to other countries will be fostering future competition. It is clear that this is an issue that should be carefully examined periodically. However, there are many reasons why this may not have a great impact on developments in Hawaii: 1) knowledge is a dynamic field that is always improving upon itself, hence, it is a renewable market, 2) often, knowledge must be extensively modified for use in a particular country, and 3) sociological and political attitudes in foreign countries may be unworkable for a sophisticated aquabusiness. In short, Hawaii has much to gain in pursuing technology transfer activities, and potential competition from Third World aquaculture production does not appear to be of serious concern at this time.

One important component of State efforts to attract aquabusiness in the Research, Training and Technology Transfer sector is a research and demonstration facility. A tropical aquaculture center, to be located at Waialeale on Oahu's Northshore, has been in the planning stages since 1978 by the University, DLNR and DPED. Presently, a preliminary design is nearly complete; however, State funds are not available to finish the design and begin first-phase construction. The preliminary estimate of the cost of a complete facility is \$18 million. At this "price tag," private and public sector support for the facility has been weak.

In concept, a multi-purpose, multi-use, multi-user group facility where research, training, education and demonstration activities can be carried out by public and private sector groups is desirable. It could be a place where training of local and out-of-state aquaculturists could take place, where production improvement research could be carried out, where new technologies could be demonstrated and spun-off to commercialization and where extension/education activities could occur. The "Tropical Aquaculture Center" represents one way of implementing this multi-purpose facility concept; however, other joint public/private sector or private sector approaches should be examined to achieve a flexible and cost-effective result.

Hawaii has a great opportunity to gain economically from international, national and local aquaculture research, training, education and consulting. To realize these benefits, Hawaii should: 1) develop the necessary infrastructure, 2) maintain a high standard of professional conduct, and 3) develop a highly successful Commercial Production sector. Hawaii has much to gain by aggressively seeking research and consulting dollars and a coordinated approach could be fostered by the following actions:

- The State should sponsor a series of small workshops for all groups interested in the further development of the Research, Training and Technology Transfer sector. These workshops would focus on developing a coordinated approach to making Hawaii a center of excellence for aquaculture research, training, education and consulting.
- The State and the private sector should jointly examine the need, cost and potential benefit of a large-scale multi-purpose, multi-use and multi-user group facility. This would make Hawaii more competitive in attracting research, training, education, and demonstration activities.

C. Marketing and Economics

The crucial issues of marketing aquacultured products, and the economics of their production were considered in three parts: 1) marketing, 2) availability of capital, and 3) the cost of doing business.

1. Marketing

The local seafood market is substantial and highly diversified, with a large tourist component. A recent survey indicated that seafood consumption in the State is nearly 40 million pounds annually. Per capita seafood consumption in Hawaii is more than two and one-half times the national average. Approximately 55% of the fishery products consumed locally are imported and nearly 40% are sold in frozen form. Significant opportunities exist for substituting fresh, locally-grown fish and shellfish for frozen imports. It has been estimated that the total value for the fishery products market in the Islands is upwards of \$150 million a year.

Primary export markets which have been targeted for Hawaii's aquacultured products are Japan and the mainland United States, particularly the West Coast where 1.5 million residents of Asian-Pacific descent live. While these markets appear to be large and potentially lucrative, access will be constrained by a variety of factors including: 1) low or inconsistent volumes available for sale, 2) limited and expensive transportation options, 3) tight control of points-of-access by a few companies, 4) difficulties involved with transporting perishable products, and 5) traditional business practices that are often cumbersome and unfamiliar. The costs required to develop and maintain export markets, may be a formidable constraint to market expansion, particularly for products such as freshwater prawns that are relatively unknown to the consumer. Moreover, Hawaii's seafood distributors are not export-oriented, as illustrated by the fact that only 12 of 105 wholesale businesses exported their products in 1979.

Hawaii's aquaculturists have, with the assistance of State promotional funds, gained considerable marketing experience with freshwater prawns. Although some individual producers may disagree, most prawn aquaculturists are readily selling their product locally or on the Mainland. Demand far exceeds supply for competitively-priced prawns, with certain ethnic groups purchasing substantial quantities of product. Unfortunately, supply limitations have prevented penetration of large volume Japanese and Mainland export markets. Despite this situation and the reported poor results of Amfac Aquatech's test marketing on the Mainland, State personnel and prawn farmers continue to receive numerous requests to purchase freshwater prawns.

The knowledge gained from marketing freshwater prawns can be applied to other aquacultured products. Fresh-chilled and frozen prawns can occasionally experience quality control problems (e.g., product mushiness) after the product

has left the farm. This strongly suggests that certain aquacultured products may require modified handling procedures and furthermore, it may be necessary to educate distributors and consumers. Extending the shelf-life of fresh and frozen products is another important aspect of market development and expansion. Furthermore, in the early stages of the industry's development, supplies are likely to be inconsistent, and sales channels that can adjust to irregularities in supply must be identified. Finally, the prawn marketing experience indicates that aquaculture producers should attempt to harvest and sell products to conform to the market's needs and schedules.

The present problems encountered in marketing aquacultured products stem primarily from production problems, i.e., inconsistent and inadequate supplies. Demand for fresh, high quality seafood products is very strong. The diverse local seafood market, with its large number of seafood eaters, should not be under-rated because it can readily support the development of a substantial aquaculture industry. Moreover, the changing dietary preferences of health-conscious Americans and the close proximity of the Japanese market bode well for the demand for Hawaii's aquacultured products, though access to these markets will require creative and determined approaches. Finally, by filling in gaps in seasonal supplies, increased aquaculture production will more than likely complement rather than compete with fresh capture fishery products.

The small size of Hawaii's aquaculture industry is limiting aggressive market expansion because of inconsistent, unpredictable production. This situation could be improved by the following actions:

- Though this action may be premature, aquaculture producers should consider joining together to form a professionally-managed marketing cooperative in order to achieve the volume of product necessary to service the existing market and open new segments.
- Aquaculture producers should target distribution channels and sales outlets, e.g., specialty outlets, that can readily adjust to supply irregularities caused by unpredictable or seasonal production.

As aquaculture production grows, orderly development of local and export markets to keep pace with supply is desirable. Today, certain producers are not adequately utilizing local seafood distributors. Moreover, most of Hawaii's aquaculture farmers have neither the time nor the resources to carry out extensive market development programs. Improvement in the situation could be fostered by the following actions:

- Before pursuing an export market, aquaculture producers should concentrate on the local seafood market by focusing on import substitution. In particular, substitution of fresh "Hawaii grown" seafood for frozen imports should be emphasized.

- Aquaculture producers should strive to develop unique market niches for locally-grown products to reduce opportunities for future competition from local capture fisheries or imports.
- The State and the private sector should jointly provide promotional and market development assistance to open new markets and relieve competitive pressure as greater amounts of product become available.

Freshwater prawns, both fresh-chilled and frozen, have had quality control problems frequently brought on by poor handling after the product leaves the farm. These problems could be reduced by the following actions:

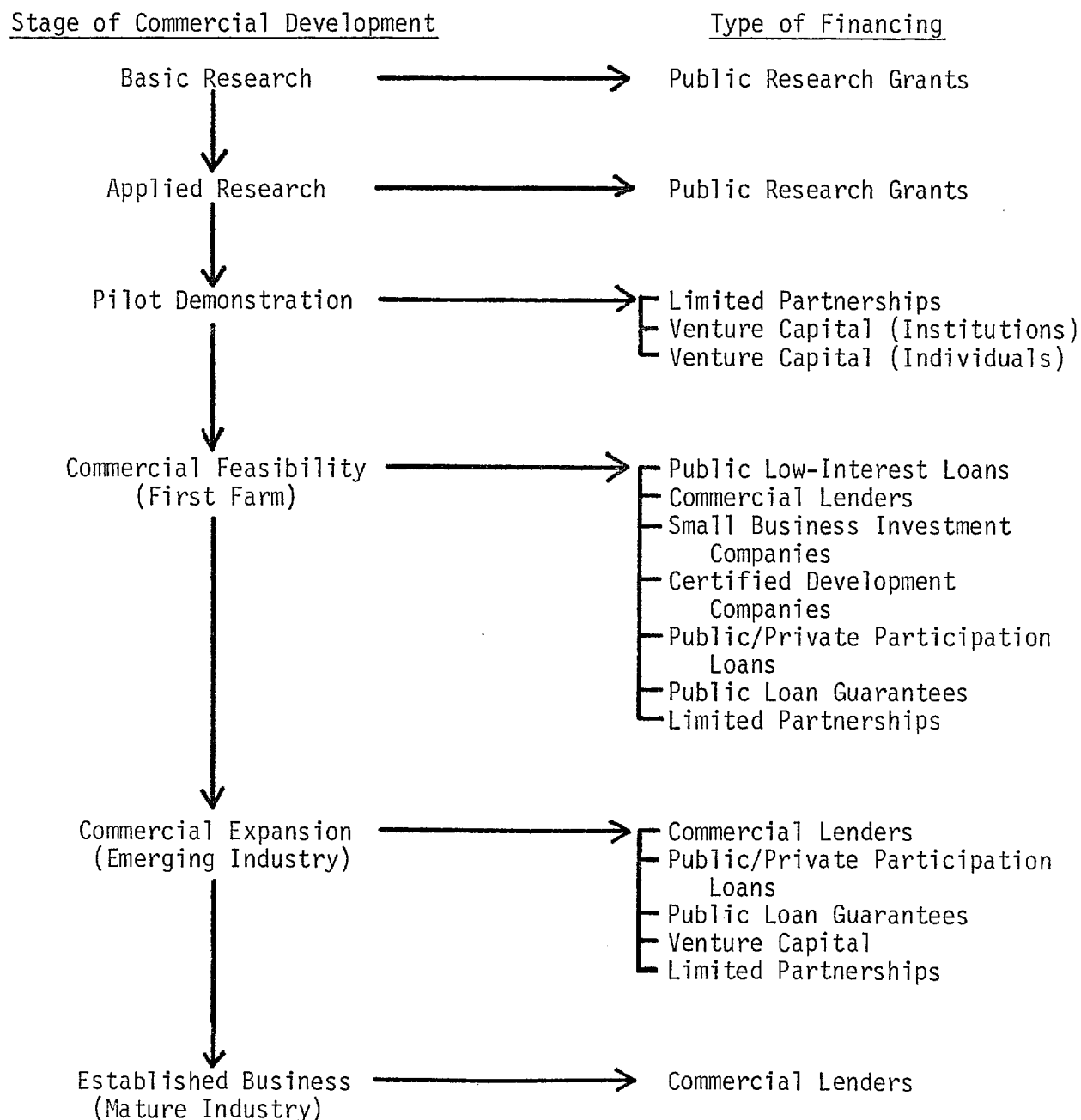
- The State should assist the prawn industry in formulating a strategy to educate "middle-men" and end-consumers as to the proper handling of freshwater prawns and systematically investigate causes of complaints about the product.
- The State should improve local capabilities for conducting research on techniques for processing and handling freshwater prawns. For example, innovative mechanical processing methods to reduce the potential for "mushiness" and extend shelf-life should be developed.

2. Availability of Capital

A lack of investment capital for aquaculture ventures and recent exceptionally high interest rates have affected the growth of Hawaii's emerging aquaculture industry. At the present time, commercial lenders continue to view aquaculture as a highly risky business, and loan officers must see a clear potential for repayment to justify the loan. Commercial lenders hold this opinion because most aquaculture ventures lack an adequate track record, financial data, and personnel with farm management skills. Furthermore, recent articles in the popular press have given the misimpression that commercial aquaculture in Hawaii is a failure. These have tended to make loan officers hesitant to offer financing. In actuality, there are aquaculture species and technologies that have proven their profitability in Hawaii and on the Mainland, and many more are attempting to "make the leap" from the research and commercial demonstration stage to full-scale commercial development.

Fortunately, at this stage of the industry's development, other sources of financing are available which accept the higher-risk element (Table 6). The development of the United States agriculture industry demonstrated that the public sector provides the majority of funding for species/technology development through basic and applied research. Once a species has been identified as having commercial potential, higher-risk capital, e.g., R&D limited partnerships and venture capital, is available for pilot demonstration and commercialization. In addition, government lending agencies also provide a mixture of financing vehicles to carry an unproven technology to commercialization, since these agencies are better able to assume the risk of a lengthy repayment time (Table 6).

Table 6 Financing Alternatives Typically Used for Various Stages of Commercial Aquaculture Development



Sources of high risk and venture capital exist both in Hawaii, on the Mainland, and in foreign countries. The State government has provided an Aquaculture Revolving Loan Fund, located in the Department of Agriculture (DOA), which acts as a "lender-of-last-resort" and offers a lower-than-market interest rate of 5% to aquaculturists.

The DOA Aquaculture Loan Program, initiated in the early 70's, is geared towards helping the new, small-scale aquafarmer who cannot obtain conventional financing. The applicant must be turned down by two outside sources. The Program, capitalized at \$700,000, has made 19 loans since its inception. In 1983, 20 requests for loans were received and there is currently a balance of approximately \$155,000.

High-risk investors want projects with high potential earnings in order to justify the financial risk. In contrast, well-known (lower-risk) agribusinesses, e.g., macadamia nuts or nursery products, are expected to have pre-tax return-on-investment of 20%-25% or more before more conservative commercial lenders will consider a loan. On the other hand, with existing high interest rates, the high-risk investor may require higher potential pre-tax earnings before offering financing to a commercial aquaculture venture. It is difficult to generalize, but a successful well-run aquabusiness (medium- and high-intensity) can have pre-tax rates of return in the 15% to 30% range, and some high-value products yet to be commercially-grown in Hawaii may have even higher returns. Small-scale or family-run operations may also offer returns of this scale or higher, but this is primarily due to their failure to account for all the costs of production.

In conclusion, most aquaculture technologies do not appear to be eligible for commercial loans; however, other sources of capital which accept higher risks are available. If an aquaculture company wants to utilize sources of high-risk capital, such as venture capital, then it has the option of pursuing local, Mainland, or foreign investors. The continued expansion of the aquaculture industry would be facilitated if government and the private sector searched for ways to spread the risk among those involved in the financing.

Commercial lenders and high-risk investors need proven information in order to evaluate commercial aquaculture ventures. At its current stage of maturity, the industry does not have a lengthy track record and financial data from successful operations are not widely available. Assistance could be provided in the following form:

- The State, in cooperation with the private sector, should develop, collect and publicize the technical and financial information needed by commercial lenders and high-risk investors to evaluate aquaculture projects.

At the present stage of development of the aquaculture industry, entrepreneurs need greater access to more sources of high-risk capital. Local, as well as Mainland and foreign sources should be exploited. Availability and access to high-risk capital can be encouraged by the following:

- Private- and public-sector aquaculture developers should join forces to publicize Hawaii's interest in attracting high-risk capital for aquaculture projects. For example, the State should study the desirability of establishing a state clearinghouse for inquiries from venture capital firms and entrepreneurs with projects which need funding.
- The State should provide aquaculturists assistance in locating and accessing sources of high-risk capital, including providing advice in how to write and package aquabusiness proposals.

Though the Department of Agriculture's Aquaculture Revolving Loan Fund has assisted many aquafarmers since its inception, major improvements could be made to make the program more effective. Actions to be considered should take the following form:

- The State should review and evaluate the present Aquaculture Loan Program so that it will have a more developmental role, rather than serve as a "lender-of-last-resort." One possibility would be to make access easier; for example, there could be, with the consent of local banks, a simple "assets and income" test to qualify for a loan rather than the present procedure which requires that the applicant be turned down by two outside sources. This has resulted in a "facade of rejection." Another suggestion would be to encourage program administrators to aggressively seek participation capital from outside sources, and search for novel ways to share the risk of development. For example, State funds may be used to reduce interest rates on conventional bank loans or to provide loan guarantees.
- The DOA loan program, based upon its success, should be capitalized at a level to allow for the development of a more flexible aquaculture loan system to meet the needs of the industry. In concert with this increase in available funds, increases in loan limits should be instituted so that the program will be applicable to larger, medium-intensity aquaculture operations.
- Loan program administrators should strive to utilize all available public-sector aquaculture expertise, particularly that found in the DLNR, to evaluate the technical and economic feasibility of projects applying for State aquaculture loans.

3. Costs of Doing Business

The costs of starting-up and operating a commercial aquaculture farm in Hawaii are generally perceived as being higher than for similar types of farms on the Mainland. There is often a tendency to compare these costs with those in Lesser-Developed Countries (LDC); however, this is very misleading and inappropriate because of the extreme differences in government objectives, basic resources, social structure, culture and political stability. Commercial aquaculture endeavors in LDC's are, for the most part, low-intensity operations which are generally not suitable for Hawaii (Table 5).

Significant start-up costs include the acquisition of land (most frequently by a long-term lease), obtaining the necessary permits, and constructing and equipping the farm (e.g., earth-moving in the case of pond construction and the purchase of pumps and pipes). The costs of materials and equipment tend to be high because of shipping distances for the raw materials, and the costs of certain critical transportation and storage infrastructure. As a general statement applicable to all businesses, average construction costs are 5% to 10% higher in Hawaii than on the Mainland, though for some projects costs can be lower.

The largest operational costs for aquafarming are capital, labor (especially the cost of Workmen's Compensation), feed and energy. For medium-intensity aquaculture, labor and feed are the dominant cost items. Small-scale or family-farm operations often do not account for all costs such as labor ("sweat-equity"); therefore, while they theoretically should have a negative cash-flow, they can instead return a profit. In actuality, Hawaii's labor rates are 50 cents/hour lower than the national average, making the State very competitive in the production of some exportable goods (excluding shipping costs). The cost and availability of appropriate feeds and feed ingredients will continue to be major concerns as the industry diversifies, since the State has few local sources of ingredients.

Start-up and operating costs for aquaculture farms will generally be higher than comparable farms on the Mainland. Many cost categories can be managed and will, no doubt, be reduced as research constantly improves farm management and new technologies are developed. Other cost categories are characteristic of doing business in Hawaii, e.g., transportation and energy, and offer less hope of being reduced in the future. High start-up and operating costs act as a disincentive to aquaculture investment.

The costs associated with starting up and operating a commercial aquaculture farm in Hawaii are generally high. Some costs can be addressed by government actions, while others are inherent in doing business in the State. The cost-burden on commercial aquaculture projects may be reduced by taking the following actions:

- The State should immediately take steps to reduce the burden of cost imposed by permits and regulations for starting and operating commercial aquaculture facilities. For example, unnecessary permit requirements should be eliminated and delays caused by inefficient and slow processing of applications for approvals (e.g., for zoning, roads, water lines, telephone lines, setbacks, wells, and discharges) can significantly reduce start-up costs.
- The State should examine the Workmen's Compensation Program rate structure and the law itself in an effort to reduce the high cost of providing benefits. The Committee is aware that the 12th State Legislature authorized a comprehensive study of the entire program and suggests that changes in the aquaculture situation be considered in the context of modifications in the entire program.
- The State and the private sector should initiate cooperative research, development and demonstration projects directed at reducing the major costs of production and improving the yields from existing aquaculture technologies in order to improve industry profitability.

D. Water and Land

Hawaii's basic natural resources of water and land are addressed in the following sequence: fresh water, brackish and salt water, and land. The Committee focused on the characteristics and availability of these resources around the State.

1. Fresh Water

Freshwater availability, for aquaculture purposes, varies a great deal in the Hawaiian Islands. The northeastern side of the chain receives the most rainfall. The majority of the perennial streams are also found on the northeastern side of the Islands. Neighbor Islands generally have excess ground water, though certain regions may be drier than others. Oahu, where 80% of the State's population lives, has freshwater limitations and supplies are highly regulated.

Oahu's freshwater supply is very constrained. Approximately 99% of all fresh water consumed on Oahu is from groundwater sources. About 25% of the total water used is for domestic purposes and about two-thirds for agricultural usage. Notably, agriculture on Oahu and all other Islands consumes a large percentage of the total water used.

On Oahu, use projections indicate that the freshwater supply will equal demand in the year 2000 if the level of agricultural activities remains constant. Since the economically-troubled sugar and pineapple industries are the primary crops utilizing water, as time goes on both industries will, no doubt, be taking significant amounts of acreage out of production, and thereby releasing water for other uses. Water resource planners have not taken this possibility into their calculations, and have limited freshwater usage for aquaculture developments.

Hawaii's leading aquaculture crop is freshwater prawns. The majority of prawn aquaculture farms utilize two to three times the amount of fresh water used by furrow-irrigated sugar production, i.e., 20,000 to 30,000 GPD/crop acre vs. 10,000 GPD/water acre. It is important to note that freshwater aquaculture production systems, e.g., the type used by freshwater prawns, can be designed as recirculating or multiple-water use systems and integrated with agriculture operations. Moreover, aquaculture systems can recharge the freshwater aquifer if they are appropriately designed and placed. Most freshwater aquaculture in Hawaii today, however, is in the coastal plains where there is limited opportunity for recharge.

Public management and control of Hawaii's freshwater resources is a complex issue. A 1978 Constitutional Convention amendment suggested that one State agency should control all surface and groundwater resources. Currently, regulation and control of fresh waters is shared by the State Department of

Land and Natural Resources and the various County Boards of Water Supply. This leads to confusing and sometimes contradictory policies. As a general assessment, fresh water is difficult to obtain in Hawaii and it is practically impossible to get permission for new uses from the water authorities on Oahu. It is strongly emphasized that government restriction of freshwater use is not a good management philosophy because there is no flexibility or room for growth.

Hawaii possesses some of the finest freshwater resources in the world. Fresh water is available on all Islands, but there are regulatory restrictions, as well as cost-of-development constraints associated with its use for commercial aquaculture purposes. The State does not have a clearly defined over-all freshwater resources management scheme. Finally, if freshwater aquaculture is to continue to expand in Hawaii, then a realistic balance between preservation of freshwater resources for future generations and use of fresh water for economic development must be achieved.

Presently, State and County freshwater resource planning and preservation policies are not adequately considering the needs of aquaculture. In particular, freshwater availability is restricted on Oahu and commercial aquaculture is not a recognized priority in allocation decisions. Aquaculture development should be encouraged by carrying out the following actions:

- Prevailing government attitudes toward strict preservation of fresh water for future, vaguely-defined domestic consumption should be changed in favor of policies which adequately protect Hawaii's freshwater resources, while permitting their use for economically-beneficial and non-degrading uses such as freshwater aquaculture.
- State and County governments should encourage input by aquaculturists into the development of a statewide water management scheme. The Committee is aware that such a management scheme or water code is presently under development and will be presented to the 1985 State Legislature.
- Fresh water used for aquaculture should be included within the definition of agricultural water use for government planning and development purposes and should receive the same benefits and policy considerations as agricultural usage.
- The freshwater usage "ceiling" in the Kahuku area should be carefully re-examined by State DLNR and County Board of Water Supply experts to determine if additional fresh water is available for expansion of commercial aquaculture activities.
- Freshwater aquaculturists, particularly those on Oahu, and the State should encourage aquaculture production systems that recycle water, or utilize the discharged water for agricultural crops (multiple use).

2. Brackish and Salt Water

Commercial aquaculture development is not tied exclusively to fresh water, but can also utilize Hawaii's abundant brackish and saltwater resources. Brackish water, a mixture of salt water and fresh water, is defined as water with more than 250 parts per million (ppm) of salt (chloride). Salt water has approximately 18,000 ppm of salt. It is important to note that brackish water is not independent of the freshwater supply, but is the result of the constant mixing of fresh water with sea water.

Hawaii has a very valuable aquaculture resource in the numerous volcanic and limestone aquifers from which clean, naturally-filtered brackish and salt water can be pumped. Useable volcanic aquifers occur throughout the Islands near the coast. Limestone aquifers are located along the coast, but are more selectively distributed around the State. Because of these aquifers, brackish water is abundant and exists almost everywhere along the edges of the Islands. The supply of salt water is independent of the brackishwater supply and is, of course, in infinite supply.

Proper placement of brackish and saltwater ponds is an important consideration for both the private and public sectors. Hawaii has two broad categories of soil: gray and red. Generally, gray soils overlie dense caprock along the coast, and hence brackish or saltwater ponds would not percolate into and contaminate the freshwater aquifer present beneath them. Red soils are found upland, above the coastal plain and are loose in structure. They would, therefore, be susceptible to downward percolation from brackish and saltwater ponds. A related consideration in the placement of brackish and saltwater ponds is the likely increase in salt content of the underlying soils. Once a saltwater pond is placed on the land, it would take some time for rains and irrigation systems to make the soils salt-free again.

In conclusion, the use of brackish and saltwater aquaculture would tend to relieve the pressure on available freshwater supplies and make economic use of an underutilized resource. Hawaii's brackish and saltwater aquifers offer very significant potential aquaculture development; however, site selection will be important.

Increased utilization of Hawaii's brackish and saltwater resources for land-based aquaculture can be encouraged, without threatening freshwater supplies and soil productivity, through the following actions:

- State and County governments should, after careful study, take a policy position that land-based brackish and saltwater aquaculture is acceptable on all the Islands, unless potential degradation of drinking water is clearly demonstrated.

- State and County governments should encourage direct brackish and salt-water discharges from coastal aquaculture facilities when nearshore uses and environments are compatible with this activity, as aquaculture effluents are relatively benign discharges. Moreover, the effluents in most instances will benefit selected nearshore environments by increasing their overall productivity through the addition of valuable nutrients.

3. Land

Hawaii has large amounts of land that are suitable for various types of aquaculture development. A gross inventory of lands suitable for aquaculture has identified 135,000 acres of primary lands and 500,000 acres of secondary lands throughout the Islands. Primary and secondary lands are those outside the Urban District and below 3,000 feet in elevation and are less than 5% in slope, have fresh, brackish or salt water potentially available, and average air temperatures generally above 20°C. Primary lands also have clay, loam or clay-loam soils which can easily be compacted into ponds. Secondary lands have less suitable soils and include lava lands. These gross assessments do not, however, catalog the existing land use and availability for future development.

Though apparently many acres of land are available, commercial aquaculturists are currently having great difficulties finding appropriate sites because land is expensive to buy or lease, and water may not be readily available. One reason for this situation is the imposition of land-use restrictions for purposes of preserving wetlands, coastal lands and other prime aquaculture areas. These restrictions have limited commercial use of highly desirable areas, despite widespread acceptance of the concept that aquaculture is a compatible use. Moreover, attitudes toward the preservation of fresh water for future vaguely-defined domestic use have prevented expansion of existing aquaculture operations and will preempt future developments.

Another reason for difficulties in locating sites is that land in Hawaii is under the control of a relatively few entities and their attitudes towards aquabusiness have been cautious. This is, in large part, due to several factors: 1) large landholders are not aware that certain of their holdings are suitable for selected types of aquaculture, 2) landowners are not interested in aquaculture because of its negative business image and the perceived risk, and 3) landowners are looking for a higher return on investment.

The State of Hawaii is the largest landholder in Hawaii, though much of its holdings are watershed, forest reserves and parks which are not suitable for commercial aquaculture. The State has increased the availability of sites for diversified agriculture development by instituting the Agricultural Park Program. In this program, the State prepares the site and develops the infrastructure, e.g., water and roads, and then leases it to qualified farmers at preferred rates. The development of agricultural parks is a long-range

program to bring more land into agricultural use. Planning and budgeting for parks takes a long lead time. Presently, aquaculture is a permitted use in agricultural parks under the statutes; however, there are currently no aquaculture operations in agricultural parks.

The park concept has direct applicability to commercial aquaculture development. The State and/or the private sector could develop freshwater or brackish/saltwater aquaculture parks for aquafarmers. In addition, freshwater aquaculture could theoretically be integrated into agricultural operations to gain a multi-use of the water resource. These small farms could be the nucleus for further expansion of the industry and would inherently lower the costs and risks involved in commercial development.

The final consideration in land availability is the fate of the sugar and pineapple industries. There are approximately 250,000 acres of land in sugar and pineapple production and much of this land is also suitable for aquaculture. However, it is clear that commercial aquaculture activities will not replace sugar and pineapple production on an acre-for-acre basis. This situation is largely due to the differing modes of production, operational inputs (e.g., water, energy, and labor), and outputs (e.g., product and market conditions of the two activities).

Prospective commercial aquaculturists are having great difficulties in finding appropriately-sized, reasonably-priced sites with adequate water supplies. Large landholders need more exposure to successful aquaculture ventures to be convinced of their viability. Aquaculturists can be greatly assisted in finding and securing appropriate, reasonably-priced sites by having State and private landholders cooperatively undertake the following actions:

- The State and major private landholders should exchange information and cooperate to identify private lands that are suitable and available for aquaculture. This could be achieved, for example, through a joint analysis of a proposed site and the project's feasibility, as well as referral of potential aquaculture projects to land managers.
- The State should assess State-owned lands, particularly those in unprofitable sugar production, to determine their suitability for aquaculture development and then, to encourage private investment, offer the lands identified at reasonable rates.
- The State should develop aquaculture parks to increase the availability and accessibility of sites for commercial aquaculture activities. This program could be modeled after the State Agriculture Park Program which identifies and plans a site, develops the necessary infrastructure, and leases the lots to qualified farmers at reasonable rates.

E. Government Activities

State and County governments have major roles to play in the encouragement of aquaculture development in Hawaii. Local government activities are considered in three areas: development, research and extension, and regulation.

1. Development

Historically, the public sector has provided a great deal of support and encouragement for the development of an aquaculture industry. Aquaculture development policies are included in the State Plan, as well as in County development plans. Notably, Hawaii's congressional delegation has taken a leadership role in fostering the national aquaculture development initiative. As a result of these efforts, the State has gained a national and international reputation for its accomplishments in aquaculture planning and development.

In November, 1978, Hawaii became the first state in the nation to publish a State aquaculture development plan. *Aquaculture Development for Hawaii* helped focus State, County and private-sector efforts on a dual goal of:

"the realization of commercial aquaculture production as a major economic activity and the establishment of the State as a national and international center of aquaculture expertise."

State funding for aquaculture development activities increased to implement the recommendations of the Plan. The Aquaculture Development Program (ADP), then situated in the Department of Planning and Economic Development (DPED), was given implementation responsibility (Table 7).

The Department of Land and Natural Resources (DLNR) was made the permanent lead agency for aquaculture development when the ADP was transferred from DPED in January, 1981. The ADP functions in three broad areas: 1) statewide planning, coordination and communication, 2) provision of support services in the areas of information collection and dissemination, permit acquisition, species and site selection, marketing and economics, and disease diagnosis and prevention, and 3) funding and co-funding research, development and demonstration projects. These functions assist in creating a pro-aquabusiness investment climate, reducing site evaluation and start-up costs, and helping individual aquabusinesses to solve problems and improve production technologies.

Principal government agencies involved in non-regulatory areas of aquaculture development, in addition to the DLNR (the lead agency), are the Department of Agriculture (DOA), the DPED, and the University of Hawaii (UH) (Table 8). The Departments of Agriculture and Planning and Economic Development assist in State development efforts by supplying financial assistance and research support, respectively. The University of Hawaii system provides a nucleus of

Table 7 Expenditures by the State Aquaculture Development Program,
Fiscal Years 1977-1978 to 1982-1983¹

<u>Fiscal Year</u>	<u>Amount (\$1,000)</u>
1977-1978	\$ 425
1978-1979	702
1979-1980	678
1980-1981	709
1981-1982	627
1982-1983	<u>1,108²</u>
TOTAL:	\$4,249

¹ Includes staffing, operation, and research and development projects.

² Includes a one-time \$300,000 legislative appropriation for an aquaculture and livestock feeds program.

Table 8 Current State Aquaculture Activities (non-regulatory)

Department of Agriculture -- Agriculture Loan Division

- Aquaculture Revolving Loan Fund

Department of Planning and Economic Development -- Energy Division is lead organization

- OTEC-Mariculture R & D

University of Hawaii System -- College of Tropical Agriculture is lead organization

- Research
- Education
- Training
- Cooperative-Extension with Other State Agencies

Department of Land and Natural Resources -- Lead agency for State aquaculture development

- Aquaculture Development Program Office (Chairman's Office)
 - Planning, Coordination and Communication
 - Support Services
 - State Funding Research, Development and Demonstration Projects
- Division of Aquatic Resources
 - Natural Stock Enhancement
 - Baitfish Development
 - Prawn Research and Cooperative-Extension Services
 - Hatchery Activities for Recreational Fishing and Development
 - Commercial Prawn Farming

personnel and facilities to conduct aquaculture research, training and education activities. In addition, the Counties of Kauai and Maui are in the process of preparing County aquaculture development plans to guide their efforts.

Communication and coordination among agencies within government, and between government and the private sector are areas that need constant attention. Ad hoc mechanisms to enhance coordination and communication have been instituted in recent years, e.g., the State Aquaculture Advisory Council, the Hawaiian Prawn Research Steering Committee and the Hawaii Prawn Producers Association; however, formal mechanisms should be developed. One major benefit of this action would be greater industry access to, and influence on, government funding decisions.

Another important area in need of immediate attention is the implementation of State policy to encourage commercial aquaculture development. In contrast to the very positive, pro-aquaculture development attitudes of policymakers in State government, the lower levels of government can be unsupportive of environmentally-sound and socially-acceptable aquaculture projects. Incidents were noted where State staff obstructed worthwhile aquaculture projects for reasons of personal hostility, gross ignorance, excessive conservatism or protection of "turf." Such a situation, in the regulatory area for example, acts as a strong disincentive to the prospective aquaculturist in carrying out the difficult task of planning, organizing and financing the venture.

In general, the public sector in Hawaii has been very supportive of aquaculture development. However, as the industry matures, government should allow industry to assume more of the financial burden for research and development. The public sector should focus its efforts on areas which reduce business start-up and operating costs, as well as investment risks. The public sector should not assume a long-term, major role in financing commercial operations but should concentrate on research, development and demonstration of new technology and the provision of extension/education services. Hawaii's aquaculture industry should not be built on a foundation of long-term subsidies; however, short-term government assistance is essential to "get the industry off the ground." The most economical way the State can do this is to improve the effectiveness of the programs and facilities already in place and add appropriate new ones.

Too frequently, lower levels of government act as obstructionists, rather than facilitators, in carrying out the State policy to encourage aquaculture development. Communication and coordination between the public and private sectors could be improved by undertaking the following actions:

- State aquaculture development policy should be communicated to all levels of government to reduce the bureaucratic problems encountered by commercial developers.

- The State should designate a permanent "Aquaculture Development Coordination Council" to advise on matters related to statewide aquaculture development, as well as coordinate State activities, review the progress and status of State programs, and provide a forum for discussion of development issues. The Council should be composed of representatives from all sectors of Hawaii's aquaculture community, including key State and County government agencies.

A favorable aquabusiness development climate is a necessity if aquaculture is going to grow to become a major contributor to Hawaii's economy. Appropriate aquabusiness investment incentives to attract new ventures and encourage expansion of established firms are needed. Enhancement of the existing climate for aquaculture development can be achieved by the following:

- The DLNR should update the State Aquaculture Development Plan to formulate new guidelines for development which reflect the industry's current development pattern, stage of maturity and need for assistance. The update would provide State aquaculture development goals and objectives which are based on a realistic, up-to-date assessment of resources, opportunities, constraints, costs and potential benefits.
- The State should focus government programs on reducing industry's start-up and operating costs and lowering the risk of investment. These development efforts can require direct financial support, e.g., research and extension work, or non-monetary assistance, e.g., regulatory relief.
- The State should identify and evaluate various aquabusiness investment incentives to attract new business and encourage firms to expand. For example, a tax moratorium or credit could be given on all exported aquacultured products.

2. Research and Extension

The State of Hawaii has provided significant financial support for aquaculture development. From 1965, when prawn research began, to 1975, approximately \$.87 million of State funds and \$1.3 million of Federal funds were spent on a variety of research projects. Since 1975, approximately \$5 million in State funds have been spent on research projects and, in the same period, an estimated \$7 million of Federal monies have come into the State. It is important to note that State expenditures have increased since 1978. In broad terms, these research projects have focused on improving yields and reducing production costs for commercialized species, e.g., freshwater prawns, and fostering the development of new species and systems. These efforts have been partially responsible for private sector investments of between \$20 million and \$30 million since 1977.

Commercial aquaculturists in Hawaii have access to a wide array of extension/information assistance located throughout the State. Three categories of services can be distinguished: 1) Production and Farm Management, 2) Project

Development and Commercialization, and 3) General Aquaculture Information. Many of these highly effective services are provided on a temporary basis through year-to-year project funds, while a few services are provided through permanent State or County employees.

Production and Farm Management extension services are provided by full-time specialists in the areas of production and hatchery management, aquaculture engineering assistance, and disease prevention and diagnosis. The production and hatchery personnel (the ADP/Sea Grant Aquaculture Extension Specialist and AFRC staff) and the aquaculture engineering personnel (the ADP/Sea Grant Aquaculture Engineering Specialist) deal primarily with the freshwater prawn industry, while the Aquaculture Disease Specialist (ADP) addresses all species. All individuals are based on Oahu but have statewide responsibilities.

Project Development and Commercialization assistance is provided, for the most part, by temporary staff located on Oahu and in the three Neighbor Island Counties. The Aquaculture Development Program, as part of its planning and development mandate, provides statewide assistance to potential farmers in the areas of species and site location counseling, permit assistance, general and specific aquaculture information and marketing assistance. The ADP staff work closely with individuals in the County (Neighbor Island) offices charged with economic development who generally have responsibility for aquaculture activities. The ADP, in general, provides a government liaison, as well as an advocacy function to aquaculturists.

In the area of General Aquaculture Information, a combination of State and Sea Grant-supported individuals spend some portion of their work time providing aquaculture information to interested individuals. The Sea Grant Marine Advisory Program has agents in all four Counties of the State. The Department of Land and Natural Resources has fisheries biologists on every island but Lanai. These individuals generally work closely with the Aquaculture Development Program and the Anuenue Fisheries Research Center staff to provide on-site aquaculture information, as needed.

The State is currently providing approximately one million dollars a year in staff and research project support for aquaculture development, with approximately \$500,000 a year to the DLNR for research, development and demonstration projects. Federal funds, often for joint projects, add an equivalent amount towards research. By comparison, the agriculture industry reportedly has a \$15 million-a-year research program through the University of Hawaii, and the Hawaii Sugar Planters Association has a \$5 million to \$7 million-a-year research budget. With 1984 State fiscal constraints, it may be difficult and of questionable merit to recommend increasing the financial commitment to aquaculture development. Nonetheless, greater effectiveness can be accomplished through examination of existing expenditures and refocusing program objectives to meet the current needs of the emerging industry.

The extension services provided by the State are generally considered "good quality" and have been clearly effective in helping the industry grow and develop. However, while existing services have been effective, there is a need to expand the range of services available to keep pace with development in such areas as marine shrimp extension, stocking material for other species, and analytical services.

The staff of DLNR's Anuenue Fisheries Research Center (AFRC) has performed a key role in developing the freshwater prawn industry. AFRC developed prawn hatchery and growout technology, and then provided stocking material and extension services to encourage commercial investment through a "Cooperative Agreement Program." Presently, AFRC continues to serve the prawn industry; however, the DLNR is planning to terminate the Cooperative Agreement Program at the end of 1985. With the hatchery no longer in use for prawn production, it would be possible to re-program the facility to assist with the research and development of other species, e.g., marine shrimp.

In conclusion, the State of Hawaii is providing significant amounts of research and development support for aquaculture in a number of areas. Requests for additional funds may not be warranted at this time. More effective utilization of existing research budgets can be achieved by allowing research priorities to be jointly determined by the State and industry. State support of basic and applied research has clearly been an important incentive to encourage private investment. State-sponsored extension efforts have had a major role in the development of the industry to-date. However, extension services and research support must be periodically re-programmed and enhanced to keep pace with industry development trends.

Current State-sponsored aquaculture research and extension efforts could be improved by striving to define project objectives which better reflect the industry's production and marketing problems. Initiatives should take the following form:

- The State should develop a formal advisory mechanism, such as an "Aquaculture Development and Coordination Council," for the aquaculture industry to provide input into funding decisions. This mechanism would assure that adequate funds are directed at solving the highest priority problems and developing species of greatest commercial interest. In addition, a committee of industry representatives should be formed to specifically advise the Anuenue Fisheries Research Center on the direction of current activities and new program initiatives that would benefit commercial aquaculture.
- The State should direct the bulk of its support to encourage the development of medium- and high-intensity commercial aquaculture because these operations will provide the greatest impact on the State's economy.

- The State should enhance existing extension capabilities to accommodate the current and projected mix of commercial species and technologies. For example, a broader range of services in the areas of water quality analysis and pathology could be provided. The Anuenue Fisheries Research Center could be re-programmed to support the development of the emerging commercial marine shrimp farming sector. An initial area of focus may be production problems.

3. Regulation

Federal, State and County regulations and permits have a great impact on commercial aquaculture development in Hawaii (Appendix C). The regulatory process strongly influences such areas as siting, species choice, system design and most importantly, profitability. The uncertainties associated with permit compliance, both on the part of aquaculturists in understanding a complex and often confusing system, and regulators in understanding new, often complex technologies, can be a major constraint to aquaculture development. The time and cost of permit compliance impacts directly on the commercial aquaculturist.

Today, government is generally aware that the regulatory burden on businesses should be reduced. Though efforts have been made, problems still exist. The State of Hawaii has an on-going battle with the Federal government over Federally-mandated regulatory programs. These often do not recognize the Islands' unique environmental situation, and require variances in interpretation and application, e.g., the Underground Injection Control Program (Appendix C).

Aquaculture developers complain that Federal, State and County government regulations are cumbersome and confusing, and often give the regulating agency too much room for interpretation, particularly in the area of environmental impacts. Developers also contend that aquaculture is an environmentally sound use of resources, with very low pollution potential and should be considered a form of agriculture for purposes of regulatory interpretation.

Federal, State and County regulations can be grouped into two broad categories: 1) those that impact upon the start-up of an aquabusiness, e.g., siting and construction, and 2) those that affect the general operation of the aquabusinesses, e.g., labor laws. Troublesome areas encountered in starting an aquaculture operation include Environmental Impact Statement and Assessment, endangered species, historic site preservation, freshwater source development and disposal, brackish and saltwater source development and disposal, and construction approvals. Burdensome areas in operating a commercial aquaculture facility include Workmen's Compensation, unemployment insurance, effluent discharge monitoring, exotic species importation and disease control.

Though problem areas still remain, Hawaii has made significant strides in streamlining the regulatory process for aquaculture development. Proper planning and siting of aquaculture facilities, and the involvement of regulatory personnel early-on in the planning process can greatly reduce problems. Nonetheless, aquaculture is a new, commercial technology that is little understood by the existing regulatory regime and changes must be made in this situation if the industry is to develop further. One important change would be a shift in government attitude towards making and interpreting regulations in ways which promote rather than obstruct aquabusiness development.

The regulatory regime in Hawaii governing aquabusiness generally was established without adequate consideration of the State's unique environment and the industry's low pollution potential. The time and cost of regulatory compliance impact directly on the commercial aquaculturist and can act as a strong disincentive to investment. Improvements in the current situation could take the following form:

- The State should survey members of the aquaculture industry to determine which laws, regulations, rules and codes are being misapplied so that appropriate policy and statutory changes can be implemented to relieve the regulatory burden on commercial aquaculture.
- The State should consider reducing the time and cost of preparing an Environmental Impact Assessment or Statement by having certain aquaculture ventures defined as an exempt class of action and/or by carrying out "Master" EIA's or EIS's (e.g., for ocean intakes and outfalls) in certain areas of the State. In the latter instance, private aquaculture developers could simply amend the Master EIS for the area, thus reducing their site-development costs.
- The State should allow direct aquaculture discharges by establishing, when appropriate, a "zone of mixing variance," similar to those used to regulate municipal sewage and thermal effluents. Current policies are overly restrictive considering the State's aquaculture development policy and the relatively benign, or even positive, nature of aquaculture effluents.
- The State should strongly recommend to the Environmental Protection Agency that the National Pollutant Discharge Elimination System permit exemption criteria (Appendix C) be raised to 500,000 pounds of product a year.

The State should recommend to the U.S. Army Corps of Engineers that certain classes of aquaculture activities could qualify for a General or Regional Permit, thereby simplifying the permit procedure.

- The State should examine Historic Site Preservation laws and regulations to determine if exemption could be granted so that ancient Hawaiian fish-ponds could be modernized for commercial aquaculture production. Presently, structural modifications to revitalize and bring ponds into productive use are prohibited.
- Jurisdictional and policy conflict problems between State and County freshwater management agencies should be resolved to clarify water availability and use questions. As a case in point, the City and County of Honolulu Board of Water Supply's "Pass/No Pass Line" should conform to the pending Underground Injection Control line on Oahu (Appendix C). Also, a consistent, positive policy regarding the availability for aquaculture of subsurface freshwater outflows to the ocean should be adopted.
- Federal and State governments should clearly define the statutory and policy guidelines used to regulate the application of animal manures to aquaculture food production systems.
- Hawaii's aquatic species importation regulations and procedures should be reviewed by the State to identify ways to streamline, but not weaken, the current review process, e.g., consider shortening the 90-day review period.

V. FUTURE OF THE INDUSTRY

If Hawaii wants to develop a substantial aquaculture industry, it can. Hawaii possesses the natural resources necessary for aquaculture development and, most importantly, Hawaii's government and citizens favor its further expansion. Aquaculture also fits the State's overall strategy for economic development and diversification which encourages: 1) the production of items which can cost-effectively substitute for current imports or can be exported, and 2) the development of small businesses. The following highlights the Committee's discussions regarding the existing business climate in Hawaii and the potential growth of the aquaculture industry if the issues discussed in Section IV are effectively addressed.

A. Hawaii's Business Climate

"Business climate" refers to the sum total of the fundamental disadvantages and advantages that a particular location conveys on a commercial activity. For Hawaii, the most important factors impacting on the success of all forms of business stem primarily from geographical, geological, level-of-development and political-status considerations. Ultimately, if the State's economy is to continue to flourish, industries must be found which would mitigate the disadvantages and profitably exploit the advantages.

As part of its mandate from the Governor, the Committee identified and discussed the general disadvantages of a Hawaii location for major export-oriented businesses. These disadvantages are briefly discussed below:

- Hawaii's central Pacific location tends to isolate companies from new technological developments, multiple sources of investment capital, and major markets.
- The Island's rugged terrain and level of urban/agribusiness development make finding suitable, reasonably-priced land difficult, and competition for prime sites intense.
- The unique subtropical island environment and the desire to preserve agricultural lands from development have contributed to instilling a strong protectionist attitude in the State.
- The costs of doing business in Hawaii are generally higher than for Mainland United States' locations because of the limited industrial resource base available and the cost of labor.

- The size of the resident population presents limitations on the availability and cost of certain skilled labor. Moreover, the resident and tourist population combined represents only a "pocket market" for many forms of business and, therefore, may restrict substantial production initiatives.

Fortunately, the aggregate advantages of a Hawaii location can significantly outweigh the disadvantages for many forms of business. These advantages, some of which can also appear as "disadvantages" in another context, are highlighted as follows:

- The subtropical location of the Hawaiian Islands offers a year-round, warm climate and mild seasonal temperature fluctuations. This temperature regime is suitable for the growth of a wide variety of tropical and temperate plants and animals.
- Hawaii's central Pacific location makes the Islands a potentially active crossroads for technology exchanges and business development initiatives with Asia and the Pacific.
- The Islands have ample flat areas with good topsoil and many areas with large amounts of fresh water. Moreover, abundant supplies of unpolluted brackish and salt water can be pumped from aquifers around the State.
- Hawaii offers an urban, modern location with reliable transportation and communications systems. Technologically advanced, Hawaii has the sophisticated infrastructure and skilled labor force necessary to support high-technology developments.
- A resident population of one million people and the four-million-plus tourists who visit Hawaii every year, offer a significant start-up market for goods and services.
- Hawaii offers political stability and protection under the U.S. flag and a predictable, relatively simplified government environment for major capital investments.

Aquabusiness produces a variety of products and services that can supply both local and export markets. It is a flexible, multi-purpose activity that can be economically viable at a wide range of scales. Moreover, commercial aquaculture has the potential to take advantage of under-utilized resources, e.g., brackish and salt water, agricultural wastes and lava lands. This flexibility and diversity will help local aquaculture enterprises mitigate the disadvantages of a Hawaii location and benefit from the collective advantages.

B. Future Developments

Aquaculture has a potentially bright future in Hawaii if existing constraints are reduced or eliminated (see Section IV), and investors begin to confidently choose aquabusiness development. Two time-frames for industry development were considered by the Committee: the near-term (by 1990) and the long-term (by the year 2000).

The worldwide focus on increasing food supplies and encouraging economic development in Lesser-Developed Countries is expected to continue into the 1990's. Aquaculture will continue to be targeted as an environmentally-sound, energy-efficient means of increasing protein production. Opportunities for aquaculture training, education and consulting will increase, though the field may become increasingly competitive. In addition to international activity, the United States is expected to make a major commitment to national aquaculture development. This is illustrated by the recent publication of the National Aquaculture Plan, and the pending reauthorization of the National Aquaculture Act. Today, Hawaii clearly has an excellent reputation, and a substantial amount of aquaculture expertise to further develop this area.

The limits of expansion in the RT & TT sector are extremely difficult to project due to the rapidly changing mix of available technologies, research and development priorities, personnel and competition. If current trends continue, the potential exists to generate an annual project value of around \$10 million by 1987 (Table 9). However, major improvements in the current situation would have to occur, such as the networking of existing resources and facilities, constructing a large-scale research and demonstration facility, developing appropriate aquaculture curricula, and aggressive marketing of Hawaii as a site for aquaculture research, training, education and consulting.

Potential near-term growth appears more promising for the Commercial Production sector, despite the poor showing in 1983. Though several major firms withdrew, several other firms have continued pilot demonstration projects, and several new ventures have announced intentions to begin production. These projects, if they expand to full-scale production, have indicated that they would add the following near-term wholesale value to the industry: 1) Marine Culture Enterprises (the W.R. Grace and F.H. Prince project which had a formal groundbreaking on January 20, 1984)--\$12.5 million, 2) ORCA Sea Farms, Inc.--\$5 million, 3) the Kaluanui Farmers Association--\$1 million (estimated), and 4) Project X (not public)--\$10 million. In addition to these projects, the Farms of Kapua on the Big Island is in the process of finalizing their site, but has made no official revenue projections. Numerous small and medium-scale projects are also being planned. Based on these announced plans, the potential for the Commercial Production sector of the industry to reach \$20 million annually by 1987 is very great (Table 9).

Table 9 Growth Projections for Hawaii's Aquaculture Industry

<u>Commercial Production Sector</u>		
<u>1983</u>	<u>1987</u>	<u>1990</u>
\$1.6 M	greater than \$20 M ^a	greater than \$50 M ^b
<u>Research, Training and Technology Transfer Sector</u>		
<u>1983</u>	<u>1987</u>	<u>1990</u>
\$5.5 M	greater than \$10 M ^c	greater than \$10 M

a

Based on announced plans by those companies with sites that will expand to full-scale production, if pilot projects are economically viable.

b

Based on achieving the confidential commercial plans of some of the 15 companies that are currently expressing a strong interest in locating in Hawaii.

c

Based on improved networking of existing resources and facilities, achieving the construction of a large-scale facility, developing curriculum, and aggressive marketing of Hawaii as a site for education, training and consulting.

Furthermore, State officials suggest that by 1990, the annual wholesale value of the Commercial Production sector may be greater than \$50 million. This optimistic projection, which adds \$30 million to the 1987 value, is based on the confidential commercial plans of some of the 15 large projects that are currently expressing strong interest in locating in Hawaii. Many of these companies are already involved in aquaculture, either through the development of unique technologies or by commercial use of existing technologies in other locations (the desire of most is to transfer proven technologies to Hawaii). The systems being proposed generally involve medium-intensity earthen ponds or high-intensity raceways. Their land requirements range from 20 acres to several hundred acres. The species contemplated include marine shrimp, *Spirulina*, American lobster, freshwater prawns, red tilapia, eels and abalone. It is optimistic to speak with certainty of achieving this level of development in lieu of the recent industry track record; however, it is appropriate for planning purposes to speculate that this level of development could very well be realized.

It is apparent that a successful aquaculture industry can contribute millions of dollars in revenue to Hawaii's economy through the generation of jobs, taxes and export income. This conclusion is even more evident when the near-term potential revenues from aquaculture are compared with those of the current contributors to the State's economy (Table 10). In terms of agribusiness, sugar and pineapple production and diversified agriculture totaled over \$700 million in 1981. Currently, however, the sugar and pineapple industries are declining due to severe problems with profitability and foreign competition. Diversified agriculture offers opportunities for selected expansion, but competition from out-of-state sources may seriously limit production volumes. Aquaculture is a form of diversified agriculture which will not, within the foreseeable future, be stifled by out-of-state competition.

The projected growth of the aquaculture industry by the year 2000 is more uncertain. The State Aquaculture Plan set a long-term goal of \$334 million (wholesale) of commercial production by the year 2000. The Plan also projected that the RT & TT sector could reach \$6 million to \$10 million annually. Only the most optimistic members of Hawaii's aquaculture community would envision the aquaculture industry becoming as large as the sugar or pineapple industries by the end of the century; however, the possibility should not be ruled out. Both these long-range industry goals need to be re-evaluated in light of developing technologies and markets, and potentially available resources. With changes in the State's business climate--particularly in the regulatory area, an improved industry track record, and continued encouragement from government, aquaculture has the potential to make a major impact on Hawaii's economy.

Aquaculture fits into the State's strategy for economic development and diversification. With its dual orientation of production for local and export markets, and technology sales to those groups requiring research, training, education and consulting services, it is capable of filling a multitude of market niches. The Commercial Production sector's efforts should be focused

Table 10 Comparative Values of Industry in Hawaii in 1981

<u>Industry</u>	<u>1981 Value (\$1,000,000)</u>
Tourism Industry	\$3,200
Federal Spending	\$3,700
Sugar Revenues	\$ 328
Pineapple Revenues	\$ 221
Diversified Agriculture Revenues	\$ 192

Leading Diversified Agriculture Crops

Dairy (Milk)	\$30.3
Beef	\$28.4
Macadamia Nuts	\$26.5
Poultry and Eggs	\$20.5
Papaya	\$12.3

on medium and high-intensity systems which achieve high yields per acre, and grow high value, exportable species. Overall, near-term success will depend on improving the industry's management skills, increasing profitability, and making the State a better place to invest. Meeting long-term development goals will require improvement in the State infrastructure and the active development of export markets. The Committee concludes that the aquaculture industry should adopt the following goals:

Near-term - Strive by 1990 to make commercial aquaculture production the State's largest single diversified agriculture activity, and develop a sustained source of revenue from national and international research, training, education and consulting.

Long-term - Strive by the year 2000 to make Hawaii an important tropical seafood production site and a center of excellence for aquaculture research, training, education and consulting.

The Governor's Aquaculture Industry Development Committee believes that a diversity of aquascience and aquabusiness activities can be achieved through the dedicated, cooperative efforts of the industry and the State. If decisive action is taken now to address current problems and reduce constraints, aquaculture can grow to become a highly significant part of Hawaii's economy.

APPENDIX A
COMMITTEE ORGANIZATION AND MEMBERSHIP

Organization

In August, 1983, Governor George Ariyoshi appointed a thirteen-member committee, chaired by William Rowland of the Oceanic Institute. The membership represented all facets of the State's aquaculture community and possessed a wide variety of experience in planning and conducting aquabusiness activities in Hawaii and around the world.

The first meeting of the Governor's Ad Hoc Aquaculture Industry Development Committee (GAIDC) was held on September 7, 1983. The Committee focused on the following issues:

1. Management
2. Technology and Knowledge
3. Marketing and Economics
4. Water and Land
5. Government Activities

The Committee explored specific topics by inviting individuals with special expertise to speak before the Committee (Appendix B). Meetings were held on a weekly basis.

Membership

The membership of the GAIDC was as follows:

1. Mr. William Rowland, Chairman
President
The Oceanic Institute
2. Mr. Gilbert Ayres
President
Hawaii Production Credit Association
3. Mr. Neal Hicks
Director of Aquaculture Research
Marine Culture Enterprises

4. Mr. Hideto Kono
Private Citizen
5. Prof. T. Aaron Lim
Director of Agriculture Programs
Brigham Young University - Hawaii Campus
6. Dr. Ed McSweeney
Vice President
Amorient Aquafarm, Inc.
7. Dr. Ronald Nolan
President
ORCA Sea Farms, Inc.
8. Mr. Robert Ota
Vice President
Bank of Hawaii
9. Mr. Wayne Richardson III
Executive Vice President
ABA International
10. Mr. Bruce Smith
President
Kahuku Prawn Company
11. Mr. Cyrus Tamashiro
Vice President
Tamashiro Market
12. Mr. Glenn Tanoue
President
Tropic Fish and Vegetable
13. Dr. James Wyban
President
Northshore Fish and Produce

APPENDIX B
INVITED SPEAKERS

1. Mr. Robert Chuck
Chief Engineer/Manager
Division of Water and Land Development
Department of Land and Natural Resources
State of Hawaii
2. Mr. Takuji Fujimura
Private Consultant
Aquacon Hawaii
3. Mr. David Heenan
President
Theo H. Davies
4. Mr. Kent Keith
Director
Department of Planning and Economic Development
State of Hawaii
5. Mr. Chester Lao
Head, Hydrology and Geology Section
Board of Water Supply
City and County of Honolulu
6. Mr. Tim Lyons
Executive Director
Hawaii Business League
7. Dr. James Maragos
Chief, Environmental Branch
U.S. Army Corps of Engineers
8. Mr. Herbert Minakami
Chief, Planning and Engineering Division
Board of Water Supply
City and County of Honolulu
9. Mr. John Mink
Hydrologist
Private Consultant

10. Mr. Sam Pooley
Industry Economist
National Marine Fisheries
11. Dr. David Ramsour
Chief Economist
Bank of Hawaii
12. Mr. Shinji Soneda
Division Chief
Environmental Protection and Health Services Division
Department of Health
State of Hawaii

APPENDIX C

SUMMARY OF MAJOR ENVIRONMENTAL REGULATORY PERMITS

Federal

A. *Federal Environmental Impact Statement*

- Legal Authority: National Environmental Policy Act of 1969 (NEPA), Public Law 91-190 (42 U.S.C. 4321 et seq.); Council on Environmental Quality Guidelines (40 CFR 1500); Executive Order 11514 of March 5, 1970, Protection and Enhancement of Environmental Quality, as amended by Executive Order 11991 of May 24, 1977.
- Administered by: Various Federal agencies.
- Applicability: Generally required for major projects involving Federal funds or permits and for projects affecting registered historic sites.

B. *U.S. Department of the Army, Corps of Engineers Permit*

- Legal Authority: Section 10 of the Rivers and Harbors Act of March 3, 1899 (33 U.S.C. 403); Section 404 of the Clean Water Act (33 U.S.C. 1344)--formerly known as the Federal Water Pollution Control Act.
- Administered by: Corps of Engineers, Fort Shafter, Hawaii.
- Applicability: Generally required for projects involving dredging or filling in navigable waters, stream diversion or impoundment, and for projects affecting swamps, marshes and wetlands.

Federal/State

A. *National Pollutant Discharge Elimination System (NPDES) Permit*

- Legal Authority: Clean Water Act of 1977 (33 U.S.C. 1344); Chapter 342, Part III, HRS.
- Administered by: State Department of Health.
- Applicability: Recent statutory amendments now provide a general exemption from permit requirements for effluent discharges from aquaculture facilities producing up to 100,000 pounds of aquatic animals per year and for facilities discharging less than 30 days/year.

B. *Floodplain Management*

- Legal Authority: National Flood Insurance Act of 1968, as amended (42 U.S.C. 4001 et seq.); Flood Disaster Protection Act of 1973, P.L. 93-234 (87 Stat. 975); Executive Order 11988, Floodplain Management, May 24, 1977 (43 FR 6030); State of Hawaii, Chapter 179 HRS, and County ordinances under HRS 62-34(18).
- Administered by: County Planning Department/Federal Insurance Administration.
- Applicability: Statewide Federal program requiring floodproofing of structures in defined flood and tsunami inundation areas and Federal flood insurance.

C. *Introduction of Non-Indigenous Species*

- Legal Authority: Chapter 150A, HRS; Regulation No. 2 of the Division of Plant Industry; Department of Agriculture Policy PI-8, Amended December 2, 1976; Lacey Act (18 U.S.C. 42); Presidential Executive Order 11987 of May 24, 1977, Relating to Exotic Organisms.
- Administered by: State Department of Agriculture.
- Applicability: State Board of Agriculture permit required for importation of certain non-indigenous species.

D. *Hawaii Coastal Zone Management Act*

- Legal Authority: Coastal Zone Management Act of 1972, as Amended, Public Law 92-583, (16 U.S.C. 1451 et seq.); Hawaii Coastal Zone Management Act, as Amended, Section 205A, HRS.
- Administered by: Hawaii Coastal Zone Management Office, DPED, Honolulu, Hawaii.
- Applicability: Administrative review for "consistency" with CZM goals and objectives, for major Federal actions/permits in CZM area.

E. *Underground Injection Control Regulations (pending implementation in 1984)*

- Legal Authority: Safe Drinking Water Act of 1974, P.L. 93-523; Underground Injection Control Rules, Department of Health, Chapter 23, Title II, Administrative Rules.
- Administered by: State Department of Health.

- Applicability: Controls the underground injection or emplacement of wastewaters; establishes "no pass" boundaries statewide.

State

A. *Hawaii Environmental Impact Statement*

- Legal Authority: Chapter 343, HRS and Environmental Quality Commission-- Environmental Impact Statement Regulations.
- Administered by: State/County Agencies in Hawaii.
- Applicability: Generally required for major projects significantly affecting the quality of the environment; for actions involving State or County lands or funds, historic sites, and for project impacting shoreline or coastal ecosystems.

B. *Instream Use Standards Regulation (pending implementation in 1984)*

- Legal Authority: Chapter 176D, HRS; Title 13, Sub-title 7, Chapter 167, Administrative Rules, Department of Land and Natural Resources.
- Administered by: State Department of Land and Natural Resources.
- Applicability: Withdrawal of water from streams, modification of stream channels (on Windward Oahu only).

C. *Shellfish Sanitation Certificate*

- Legal Authority: Chapter 328-9 and Chapter 321-11, HRS, and Hawaii Public Health Regulations, Chapter 4A, and consistency with the National Shellfish Sanitation Program, U.S.P.H.S. Publication No. 33.
- Administered by: State Department of Health.
- Applicability: Required for growing, harvesting, packing or shipping of oysters, clams and mussels.

D. *Historic Site Review*

- Legal Authority: Chapter 6E, HRS, Historic Objects and Sites, Memorials; National Historic Preservation Act of 1966, as Amended (P.L. 89-665); Presidential Executive Order 11593, "Protection and Enhancement of the Cultural Environment" (May 13, 1977).
- Administered by: State Department of Land and Natural Resources.

- **Applicability:** Allows for review of projects which may affect designated (or eligible for designation) State or Federal historic sites.

E. *Permit for Work in Shorewaters of State*

- **Legal Authority:** Chapter 266, HRS, Harbors; State of Hawaii Department of Transportation; Harbors Division, Rules and Regulations and Tariff No. 4.
- **Administered by:** State Department of Transportation.
- **Applicability:** Requires a permit for filling/dredging, construction, or placement of structures in shorewaters of State. Recent statutory changes now allow joint processing of DOT and Conservation District Use Permits.

F. *Conservation District Use Permit*

- **Legal Authority:** Chapter 205, HRS, as Amended, "Land Use Commission"; Regulation No. 4, Department of Land and Natural Resources, pursuant to Chapter 183-41, HRS, as Amended; Chapter 183-44, "Fishponds" (pertains to permit requirements for repair, reinforcement, or maintenance of traditional fishponds).
- **Administered by:** State Department of Land and Natural Resources.
- **Applicability:** Generally required for projects within areas zoned Conservation District. Aquaculture/mariculture is defined as a permitted use in Resource (R) and General (G) subzones of Conservation Districts.

G. *Designated Groundwater Control Area Use Permit*

- **Legal Authority:** Chapter 177, HRS, "Groundwater Use Act"; Regulation No. 9, Department of Land and Natural Resources (June, 1979).
- **Administered by:** State Department of Land and Natural Resources.
- **Applicability:** Required for use of groundwaters in Ewa and Wahiawa Districts of Oahu only, at this time.

County

A. *Special Management Area Permit*

- **Legal Authority:** Hawaii Coastal Zone Management Program, Chapter 205A, HRS, as Amended. Rules and Regulations adopted by the respective Counties.
- **Administered by:** Department of Land Utilization, City and County of Honolulu (Oahu); Planning Commissions on Neighbor Islands.

- **Applicability:** Recent statutory amendments exclude most aquaculture/mariculture facilities from permit requirements unless determined to result in significant environmental impact. Federal projects or permit actions must demonstrate consistency with Coastal Zone Management goals and objectives.

B. *Shoreline Setback Variance*

- **Legal Authority:** Chapter 205, Part II, HRS, "Shoreline Setbacks"; also, "Rules and Regulations Relating to Shoreline Setbacks" of the respective Counties.
- **Administered by:** County Planning Departments; Department of Land Utilization (City and County of Honolulu).
- **Applicability:** Required for projects involving disturbances or construction in the zone beginning at the highest wash of the waves and extending 20 or 40 feet inland.

C. *Grading Permit*

- **Legal Authority:** Chapter 180C, HRS. Also, County Grading, Stockpiling and Grubbing Ordinances (County of Hawaii, Ordinance No. 168; City and County of Honolulu, Ordinance No. 3968; County of Kauai; Ordinance No. 262; Permanent Ordinances of the County of Maui, Ordinance No. 639).
- **Administered by:** County Public Works Departments.
- **Applicability:** Required for major land clearing projects.

D. *Well Permit*

- **Legal Authority:** Chapter 54-33, HRS, as Amended. Rules and Regulations of the Board of Water Supply, City and County of Honolulu (May 10, 1976). Section 7-105(j) of the Revised Chapter of the City and County of Honolulu.
- **Administered by:** City and County of Honolulu (not applicable on other islands).
- **Applicability:** Required for construction of or modification to fresh-, brackish- or saltwater wells.